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A FEASIBILITY STUDY OF USING FAILURE RATE DATA TO IMPROVE INITI--ETC(U)
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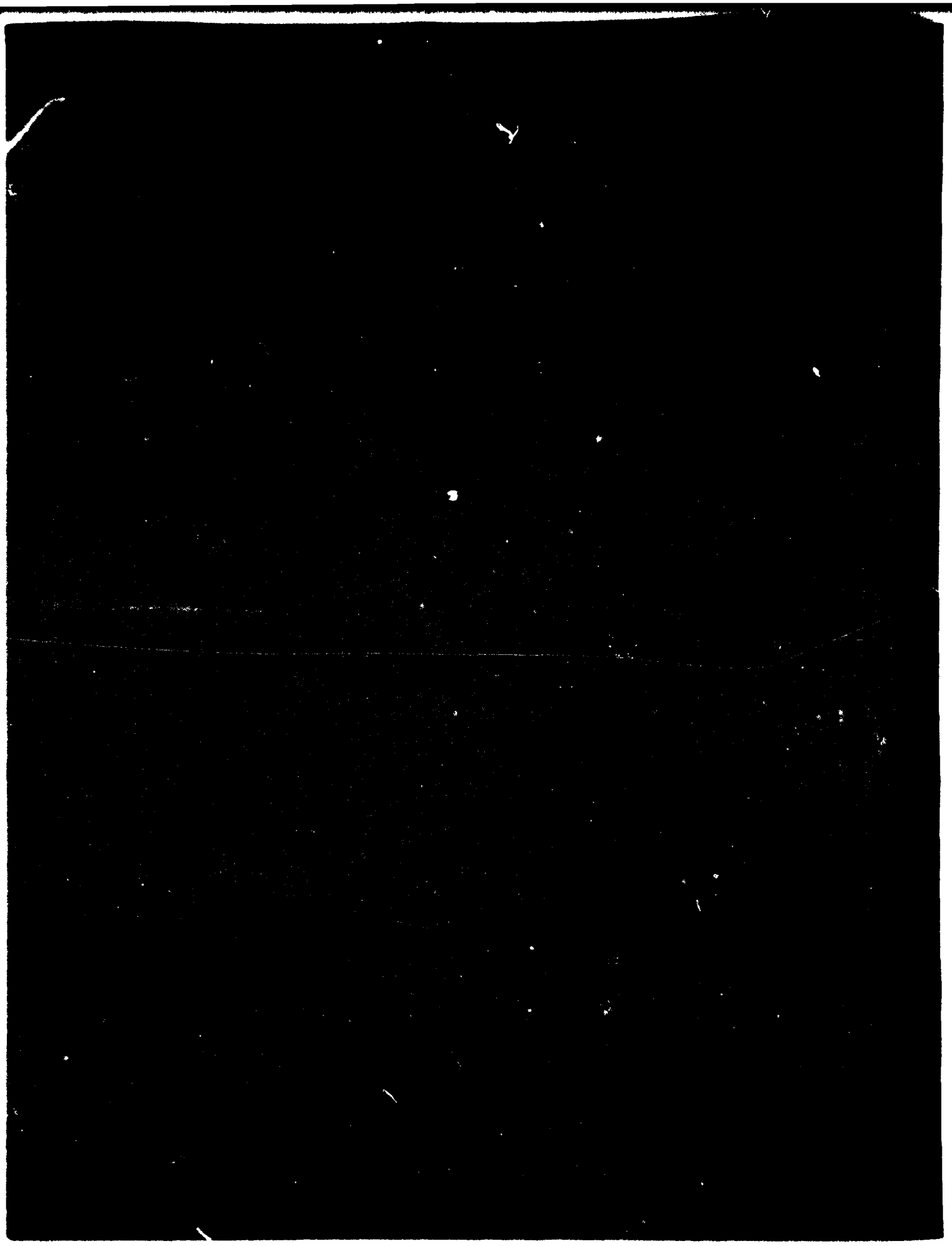

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The Initial Replacement Rates (INREP) project sought to identify sources of failure/replacement/engineering data which could possibly be used to supplement existing Navy sources of initial replacement rate data. Data generated by the Government-Industry Data Exchange Program (GIDEP) and the Reliability Analysis Center (RAC) were identified as the most likely candidates. GIDEP and RAC data were compared with existing

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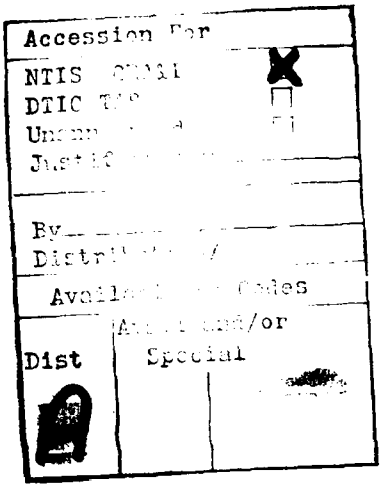
initial replacement rate data and with operational data to evaluate the range of coverage and the quality of the rates. The primary conclusion is that the range of coverage of the GIDEP and RAC data is much smaller than the range of coverage of the existing initial replacement rate data and that neither the GIDEP nor the RAC data compare more accurately with operational data than the existing initial replacement rate data. Therefore, the GIDEP or RAC data bases are not needed by the Navy for initial provisioning unless the existing initial replacement rate data do not include data for a particular item.



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ABSTRACT

The Initial Replacement Rates (INREP) project sought to identify sources of failure/replacement/engineering data which could possibly be used to supplement existing Navy sources of initial replacement rate data. Data generated by the Government-Industry Data Exchange Program (GIDEP) and the Reliability Analysis Center (RAC) were identified as the most likely candidates. GIDEP and RAC data were compared with existing initial replacement rate data and with operational data to evaluate the range of coverage and the quality of the rates. The primary conclusion is that the range of coverage of the GIDEP and RAC data is much smaller than the range of coverage of the existing initial replacement rate data and that neither the GIDEP nor the RAC data compare more accurately with operational data than the existing initial replacement rate data. Therefore, the GIDEP or RAC data bases are not needed by the Navy for initial provisioning unless the existing initial replacement rate data do not include data for a particular item.

ADMINISTRATIVE INFORMATION

The Initial Replacement Rates (INREP) project was initiated by the Provisioning Configuration and Allowance Branch of the Naval Supply Systems Command (NAVSUP 0342). Technical guidance was provided by the Research and Technology Division (NAVSUP 043). The David W. Taylor Naval Ship Research and Development Center (DTNSRDC) undertook the project in FY-77; The Logistics Division (Code 187) of the Computation, Mathematics and Logistics Department was the performing organization.

SECTION 1
INTRODUCTION

The assignment of inaccurate initial replacement rates during the initial provisioning of Navy equipment results in an undesirable allocation of the Navy's resources. If the initial replacement rate assigned is lower than the actual usage rate, a shortage of replacement parts could make an essential system unusable. If the initial

replacement rate assigned is too high, an excessive number of replacement parts could remain in a large, immobile inventory. These situations illustrate that improved initial replacement rates may result in better allocation of the Navy's resources. The INREP project investigated the feasibility of improving initial replacement rates by supplementing current initial replacement rate data with other sources of data. Although many factors other than the initial replacement rate affect the quantity of items provisioned, this study investigated only the initial replacement rate.

The initial replacement rate data currently used by the Navy were obtained from the Ships Parts Control Center (SPCC) and the Fleet Material Support Office (FMSO), both at Mechanicsburg, PA. Their cooperation in providing these data is greatly appreciated.

The INREP project is documented in two reports. The present report describes the project and discusses the data analysis. A second report, to be published later, will describe the data in greater detail and discuss the computer programs developed to analyze the data.

SECTION 2
METHODOLOGY

2.1 OBJECTIVE

The objective of the INREP Project was to investigate the feasibility of using failure/replacement/engineering data to supplement the present Navy sources of initial replacement rate data which are used during the initial provisioning process.

2.2 APPROACH

The study involved the following steps:

- Investigate the initial provisioning process and determine the current Navy sources of initial replacement rate data.
- Investigate government, industry, and academic sources for information on failure/replacement/engineering data. Analyze bibliographies and obtain applicable data.
- Develop a data analysis plan to evaluate data from the different sources.
- Perform data analysis.
- Select representative items/components for detailed analysis and compare the data from the different sources.
- Determine the feasibility of supplementing the current Navy sources of initial replacement rate data with the failure/replacement/ engineering data.

SECTION 3
CURRENT SOURCES OF INITIAL REPLACEMENT RATES

The initial provisioning process was examined to identify current Navy sources of initial replacement rate data. Items already established in the supply systems (i.e., those with a demand history) have assigned to them a Best Replacement Factor (BRF) which is an estimate of the expected annual usage of the item for each installation. The BRF is based on demand history and an initial estimate by a provisioning technician. The techician's initial estimate may come from different sources for different types of equipment. For Hull, Mechanical and Electrical (HM&E) and ordnance equipment the initial rate may come from a Median Family Replacement Factor (MFRF) which is developed by grouping BRF's for similar items of equipment. Electronic equipment provisioning technicians generally assign initial rates from a table of rates grouped by generic name.

3.1 ESTABLISHED ITEMS

Since 1963 the Fleet Material Support Office (FMSO) has been performing studies which develop replacement/usage factors used to project requirements for repair parts. FMSO reports*[1,2] document the development and use of these factors. Originally repair parts projections were based on a technician's estimate of usage. Because these estimates frequently led to the acquisition of too many repair parts, the basis for the projections was modified to include demand history.

When an item first enters the supply system, it is assigned an initial replacement rate based on a technician's estimate of use. This initial replacement rate is the BRF until the item has been in the supply system long enough to develop a demand pattern (usually one year).

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*A complete listing of references is given on page 73.

Once the item is established, the demand data are used to compute the BRF as a weighted average of recent demand data, older demand data, and the technician's initial estimate. The use of recent demand data makes the rate responsive to changes in the demand patterns of the item; the use of older demand data and the initial estimate stabilizes the rate and makes it less sensitive to short term variations in demand.

The BRF is calculated by first computing the new usage rate which is the ratio of annual demand to installed populations. Usage rates are usually updated from Navy Maintenance and Material Management (3M) populations and demand data. Then the weighted average of the new usage rate and the old BRF is calculated. Careful selection of the weighting factor provides balance between the long term influence of the old BRF and the short term influence of the new usage.

The 1975, 1976, and 1977 updates to the computerized BRF master file were obtained from the Ships Parts Control Center (SPCC). The information contained in the file which was used in the evaluation process is given in Table 1.

3.2 NEW ITEMS

When an item enters the supply system, it does not have a BRF assigned to it. Its initial replacement rate is derived from other sources such as contractor supplied data, technician's estimates, and previous replacement history for similar items. An initial replacement rate based on use of similar Navy equipment is called a Median Family Replacement Factor (MFRF)[3]. The MFRF is a statistical estimate of the usage rate developed for use in initial provisioning and is based on demand history for established items on established components which are similar in design or function to the new component.

The MFRF is computed by grouping similar items used in similar applications and determining the median of the grouped values. Prior to 1971 the mean value was used instead of the median. Various methods have been used to determine the groupings, but generic name is usually the base of the methods. Grouping the data requires developing a computer program which will most accurately extract the appropriate data from the available data bases.

TABLE 1 - INFORMATION ON BRF FILE

NAME	DESCRIPTION
NIIN	National Item Identification Number
FSC	Federal Supply Classification Code
COG	Cognizance Symbol
U/ISSUE	Unit of Issue
NOMENCLATURE	Item Name
UNIT-PRICE	Unit Price
ORDNANCE-INDICATOR	Ordnance Indicator Set = 0, item has application unique to ordnance equipments Blank, item does not have unique ordnance application
3M - POPULATION	Total population for all items installed across ships selected as data base for the collection of 3M usage data
3M USAGE	Federal Stock Number issues reported by 3M data collection system
SHF - POPULATION	Ships Parts Population Summary. The item population summary for an activity developed by the Cosal Program
SHF - USAGE	Used Quantity - Ship/Station/Squadron. A quantity developed through history of usage by total demand and demand frequency for a demand period
SYSTEM - POPULATION	The total number of times an item of supply is installed and/or in use by the operating forces and selected activities. System Active Population - Atlantic + Military Assistance Program (MAP) + Other + Pacific
SYSTEM - DEMAND	Demand observation, 4 past quarters System Random Maintenance. The quantity of an individual item supply randomly demanded from the distribution system for other than scheduled repair or overhaul programs
BRF	Best Replacement Factor. It is a rate which represents the average annual usage expected for a unit of installed population
ENTRY - DATE	The Julian date indicating when an item is first introduced into the Inventory Control Point (ICP) Master Item Record

TABLE 1 (Continued)

NAME	DESCRIPTION
BRF-DERIV-CODE	Best Replacement Factor Derivation Code

PRINT CODE	DEFINITION
No-Pop	No BRF update because of low system population.
No-Age	No BRF update because of insufficient time in Naval Supply System
No-Dat	No BRF update because of insufficient item data
No-U/I	No BRF update because of unit of issue error
No-Ord	No BRF update because of ordnance-unique override
No-REV	No update because degree of change from current BRF exceeds the acceptable limits established by the Inventory Control Point (ICP)
3M	BRF is based on 3M usage data
3M-ADJ	BRF is based on 3M usage data but has been adjusted to fall within ICP established limits of change
SH	BRF is based on Ships History File (SHF) usage data
SH-ADJ	BRF is based on Ships History File (SHF) usage data but has been adjusted to fall within ICP established limits of change
SY	BRF is based on System demand data
SY-ADJ	BRF is based on System demand data but has been adjusted to fall within ICP established limits of change
MANUAL	Manual change by ICP

TABLE 1 (Continued)

NAME	DESCRIPTION
BRF-DERIV-CODE (Continued)	Best Replacement Factor Derivation Code
	PRINT CODE: TRF — DEFINITION: Provisioning Technical Replacement Factor assigned by a Hardware System Command to a new item
% 3M-USAGE-INVALID	Percent of 3M usage records submitted for a Federal Item Identification Number (FIIN) which is considered invalid
NEW - BRF	Computed BRF
RATIO - NEW-BRF/OLD-BRF	A ratio representing a comparison of the computed BRF with the current BRF for an item
BRF - CHNG - CODE	BRF change Code Blank = BRF has changed N = No change in the BRF has occurred

The groupings are determined in different ways for different types of equipment. To designate structurally or functionally similar HM&E equipment, the Lead Allowance Parts List (LAPL) is used. The LAPL number is a five-number code whose first two digits are the same as those of the Allowance Parts List (APL) and represent a general equipment category (e.g., pump). The last three digits identify an equipment within a category on the basis of size, function, or operating characteristics. For example, it is possible to distinguish a high pressure compressor from a low pressure compressor.

Since LAPL's can be used only for HM&E equipment, other grouping methods must be used for ordnance equipment (except Strategic Systems Projects Office (SSPO) equipment) and for HM&E equipment not identified by a LAPL number. Ordnance equipments are grouped by type under the first three digits of the APL number (called CID). The remaining items (SSPO ordnance and HM&E not grouped by LAPL) are grouped by basic type under the first five digits of the APL number (called CAT ID).

DTNSRDC received the 1977 MFRF listing from SPCC to use in the data analysis of the INREP project. The information contained in the file is given in Table 2.

TABLE 2 - INFORMATION ON MFRF FILE

NAME	DESCRIPTION
SORT CONTROL CODE	Set = 1, HM&E = 2, All ordnance except SSPO = 3, SSPO ordnance and HM&E not identified to LAPL
FAMILY IDENTIFIER	(1) LAPL for HM&E items (2) First 3 of Component Item Designator (CID) (All ordnance except SSPO) (3) CAT ID (SSPO ordnance and HM&E not identified to LAPL)
BASIC NAME	Family Name
MFRF	Median Family Replacement Factor

SECTION 4
DATA ACQUISITION

An extensive investigation of government, industrial, and academic sources was conducted to determine the availability of data pertaining to initial provisioning, of failure/replacement/engineering data, and of reliability and maintainability background information. As the search progressed, primary interest centered on identification of sources of failure rate data. The investigation involved identifying relevant data banks, the types of documents in each, and the procedures for accessing the different data banks; developing the strategy for searching each data bank; and analyzing the bibliographies.

Major data banks of the following organizations were surveyed:

- Defense Documentation Center (DDC)*
- Defense Logistics Studies Information Exchange (DLSIE)
- National Aeronautics and Space Administration (NASA)
- Lockheed Information System (DIALOG)
- Government - Industry Data Exchange Program (GIDEP)
- Reliability Analysis Center (RAC)

4.1 DEFENSE DOCUMENTATION CENTER

All DOD organizations and personnel under contract to any agency within DOD must submit copies of any report with an appropriate distribution statement to DDC. "Approved for Public Release, Distribution Unlimited," or "Distribution Limited to U.S. Government Agencies Only" are acceptable statements for unclassified material. In addition to its DOD - wide collection of reports, DDC retains proceedings from conferences and symposia as well as articles from periodicals and journals. It also receives on the primary distribution list, via the attache' office, some foreign technical reports. The foreign data base is almost entirely British.

Of the four independent DDC data bases, the one accessed on the INREP project was the technical reports data file.

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*Name changed to Defense Technical Information Center (DTIC) on 14 Oct 1979.

A DDC search was requested through the DTNSRDC library. The suggested area of interest was failure rates and reliability. The bibliography received contained approximately 500 abstracts; eleven reports pertaining to failure rate data and reliability were obtained. Of these reports, three were handbooks of failure rate data developed by the Reliability Analysis Center. Many other reports identified from the DDC bibliography were ordered from one of the other orginizations.

4.2 DEFENSE LOGISTICS STUDIES INFORMATION EXCHANGE

DLSIE is the focal point in the Department of Defense (DOD) for acquistion, storage, and dissemination of logistics and management information documentation for all defense organizations. It is a DOD organization operated by the Department of the Army and is located at the U.S. Army Logistics Management Center, Fort Lee, Virginia. Since DLSIE receives documents independently, it does not have the entire DDC collection.

A DLSIE bibliography search is required for any new logistics project. Requests for DLSIE information are made by direct contact with a DLSIE Technical Information Specialist rather than through the DTNSRDC library. A custom bibliography may be obtained on a specific subject. The search is conducted by subject matter and may include all the defense services and contractors or may be limited to studies performed by specific agencies.

A custom bibliography consists of computer printout giving sponsor, performing organization, title, abstract, and other related information on all completed and on-going projects relating to the given subject. Both a Logistics Document (LD) number and a DDC accession number (AD) are given when applicable.

The following key words were selected from the DLSIE descriptor list and furnished to the analyst:

- Provisioning
- Replacement and Engineering Data
- Failure Rate
- Life Cycle
- Integrated Logistics Support (ILS)

The bibliography keyed to provisioning documents contained information on 143 documents, of which 63 were obtained. These reports covered the broad subject of provisioning for the Army, Air Force, and Navy. Many of the documents contained fundamental information required for background in the subject.

The replacement and engineering data bibliography contained 372 abstracts. Thirty-one reports dealing with data, data systems, and the use of data in reliability predictions were ordered. Many of the reports were for Army and Air Force equipment; most of the documents generated by the Navy were either out of date or were reports on the use of data rather than providing the data itself.

The failure rate bibliography contained 184 abstracts, 68 of which were ordered. Most of the reports discussed data for specific equipments, many in aviation related areas. No major collecting agencies of failure rate data applicable to the INREP project were identified.

The two remaining bibliographies, life cycle and ILS, contained 173 and 195 abstracts, respectively. The eight reports ordered contained information of a general nature.

A total of 170 reports was ordered from DLSIE. Most of these reports contained theory and background information and did not identify broad sources of failure rate data.

4.3. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Material relating to aviation, missiles, and space is maintained by NASA. Their data base is the equivalent of their entire library collection and covers NASA-originated and NASA-funded work since 1964. It also contains International Aerospace Abstracts.

NASA produced a bibliography containing 127 abstracts. Since space oriented citations were exempt from the search, only two reports dealing with theory were ordered.

4.4 LOCKHEED INFORMATION SYSTEM (DIALOG)

DIALOG is an information retrieval system that provides access to a number of independently prepared data bases. Service is provided by the Lockheed Information System and may be accessed interactively via a

computer terminal. Of the approximately 80 data bases, the ones most relevent to the INREP project were:

- National Technical Information Service (NTIS)
- Engineering Index
- Science Abstracts
- Physics Abstracts
- Electrical and Electronics Abstracts
- Computer and Control Abstracts

The data files go back seven years and contain technical reports, articles from periodicals, papers presented at conferences and symposia, and theses. DIALOG accesses one of the largest and most comprehensive collections of online data bases; it is updated regularly.

One of the special features of DIALOG is full-text searching. The user can search both the title and the abstract for any given word or words used in combination.

NTIS is a public clearing house for all unclassified government reports including DDC publicly accessible material. NTIS has broader coverage than the other organizations in that it is not limited to DOD. Its data base consists of government sponsored research, development, and engineering documentation, plus analyses prepared by federal agencies and their contractors.

An NTIS bibliography search can be structured to omit DDC publications. This is not prudent in all cases, since indexing techniques may result in inclusion of a few citations that may have been omitted in a DDC search.

The NTIS data file was queried interactively. Descriptors used were failure rate, repair parts, spare parts, failure (electronics), replenishment, and spares. These terms evolved through the search strategy employed by the Reference Librarian. As categories were compiled, sample titles were examined to ensure relevance. Two hundred fourteen abstracts were received and 15 reports ordered. Among the reports ordered were collections of reliability data generated by the Hughes Aircraft Company and by the Reliability Analysis Center.

The COMPENDEX file on DIALOG contains a machine-readable version of the Engineering Index. It provides abstracted information from

engineering and technological literature. The Engineering Index covers the major engineering journals and also includes abstracts of publications of engineering societies, papers presented at conferences, and selected government reports and books.

A technique similar to the one used for NTIS was used for Engineering Index. The descriptors used were failure rate, replacement, and spare parts. Three hundred eighty-six abstracts were received, resulting in the acquisition of 10 articles, none containing large collections of reliability data.

The other data base of abstracts investigated was Science Abstracts. This data base contains three files relating to physics, electronics, and computers, and is the largest English-language data base in those fields. It contains abstracts of journals and conference proceedings as well as technical reports. Foreign material is included but the abstracts are in English.

Science Abstracts yielded 213 abstracts, but most of them referenced foreign material and were not considered appropriate to our needs.

4.5 GOVERNMENT-INDUSTRY DATA EXCHANGE PROGRAM

The Government-Industry Data Exchange Program (GIDEP) is jointly sponsored by the Army, Navy, Air Force, Marine Corps, and National Aeronautics and Space Administration (NASA). By joint agreement, the program manager is designated by the Chief of Naval Material. The program provides participants with automatic interchange of technical data related to parts, components, and materials utilized in military and space systems. The GIDEP data banks include information generated by program participants on manufacturing processes, calibration procedures, metrology, test equipment information, and related technical test data. GIDEP also provides general technical reports and documents relating to parts, parts application, reliability specification, and in-process testing activity. Participation in the program does not require participants to generate any data not otherwise required in their work. GIDEP is simply a mechanism to ensure that data being paid for is captured and disseminated through the technical community, in an expeditious manner, for effective utilization. The program excludes classified and proprietary information.

GIDEP was originally restricted to government activities and government contractors. Because of recent government emphasis on commercial off-the-shelf items, any activity which uses and/or generates the types of data GIDEP exchanges may now be considered for membership. Currently over 300 contractors, government agencies, and instrument manufacturers are participating in GIDEP. DTNSRDC is one of the participating members of GIDEP.

The objectives of GIDEP are to:

- Provide maximum use of existing knowledge to reduce and/or eliminate duplicate expenditures for developmental parts and components as well as for calibration procedures.

- Increase the confidence level in the reliability of parts and components.

- Expedite research and development projects by avoiding repetition of accomplished tests, and by providing advance indication of possible part and component failure modes

- Provide general technical data relating to all aspects of research and development applicable to military components, parts, and materials.

GIDEP maintains four specialized data banks which are accessible to all participants through either remote terminals or microfilm/microfiche with computerized indexes. The four major data banks are:

- ENGINEERING DATA BANK (EDB) - Contains engineering evaluation amd qualification test reports, non-standard parts justification data, parts/materials specifications, manufacturing processes, failure analysis data, and other related engineering data on parts, components, materials, and processes.

- RELIABILITY-MAINTAINABILITY DATA BANK (RMDB) - Contains failure rate/mode data on parts and components based on field performance information and reliability demonstration tests on operational systems and equipment.

- METROLOGY DATA BANK (MDB) - Contains test equipment calibration procedures and related metrology engineering data on test systems, calibration systems, and measurement technology.

- FAILURE EXPERIENCE DATA BANK (FEDB) - Contains GIDEP ALERTs, which consist of objective failure information generated wherever significant problems are identified on parts, materials, and/or safety.

The RMDB was of primary interest for the INREP project. The following collections of data were obtained from GIDEP:

- Summaries of Failure Rate Data, Volume 1 (dated August 1975) and Volume 2 (dated October 1976)
- Summary of Replacement Rate Data, Volume 1 (dated August 1975) and Volume 2 (dated October 1976)
- Reliability-Maintainability (R-M) Data Summaries, Volume 3, Part 1 (dated March 1977)

Of these, the summaries of Failure Rate Data appeared to have data which could be applied to INREP.

GIDEP groups items by name into major classifications or codes. The code may further be divided by function and by observed environment. For each code, function, and observed environment a group 90% confidence interval and a mean value are calculated. Manufacturers part numbers and applications may also be provided. The units of the failure rate data are failures per million operating hours.

Examination of the GIDEP summaries showed that they contain a significant amount of data and could possibly be used in initial provisioning. Therefore, the GIDEP failure rate data base was selected as one of the data bases to be evaluated.

4.6 RELIABILITY ANALYSIS CENTER

Reviews of various reports led to the investigation of the Reliability Analysis Center (RAC) as a source of failure rate data. This DOD information analysis center is operated by Illinois Institute of Technology under contract to Rome Air Development Center, Griffiss Air Force Base, New York. RAC collects and analyzes reliability and experience information on microcircuit devices and on nonelectronic devices. The data files date back to 1967 and contain documents selected on the basis of informational currency and usefulness. Data not available through the primary source or through DDC or NTIS are not included.

RAC produces a Microcircuit Reliability Bibliography which consists of the following volumes:

Volume IB - Cummulative Index, April 1976

Volume II - Cummulative References, April 1974

Volume III - 1975 Annual Reference Supplement, April 1975

Volume IV - 1976 Annual Reference Supplement, April 1976

The Cummulative Index is an index to material in Volumes II, III, and IV. It contains a term selection guide, subject term index, corporate author index, and personal author index. Volumes III and IV are annual supplements providing additional bibliographies.

Reliability Data Handbooks contain detailed and summarized data from both field and test operations. They provide all the information necessary for a failure rate prediction for MIL - HDBK - 217B.

The following Microcircuit device Reliability Handbooks were acquired:

- Digital Detailed Data Handbooks (MDR-4 and MDR-8)
- Linear/Interface Data Handbook (MDR-6)
- Memory/LSI Data Handbook (MDR-7)
- Hybird Circuit Data Handbook (MDR-5 and MDR-9)
- Transistor/Diode Data Handbook (DSR-2)

In addition a Nonelectronics Parts Reliability Data Handbook (NPRD-1) was acquired.

Since RAC reports contained a large amount of data which could possibly be be applied to provisioning, the RAC data base was chosen as the second data base to be evaluated.

4.7 SUMMARY

Analysis and evaluation of the materials obtained indicated that we had received two types of information: basic background information on provisioning and reliability, and the GIDEP and RAC collections of failure rate data. Inspection of these failure rate data indicated that they might be used to supplement the existing Navy data. To validate this conclusion it was necessary to compare the GIDEP and RAC data with the MFRF data for range of coverage and differences in rates. Then to provide comparison with operational data, the MFRF, GIDEP, and RAC data

had to be compared to the 3M data on the BRF file. Finally, the coverage of MFRF, GIDEP, and RAC data was determined for selected stock numbers. This analysis would show the feasibility of using GIDEP and RAC data to supplement existing Navy sources of initial provisioning data.

SECTION 5
COMPARISON OF GIDEP AND RAC DATA WITH MFRF DATA

5.1 BACKGROUND INFORMATION

DTNSRDC acquired the 1977 Median Family Replacement Factor (MFRF) data from the Ships Parts Control Center (SPCC). The MFRF's for Hull, Mechanical and Electrical (HM&E) equipment are grouped accordingly to Lead Allowance Parts List (LAPL's) numbers which combine equipments that are structurally or functionally similar. The 1977 MFRF file contained 44,405 MFRF's listed by LAPL number for HM&E equipment. Ordnance equipments are grouped by the first three digits of the Allowance Parts List (i.e., CID) and there were 4,449 MFRF's for ordnance equipment. All remaining items, including Strategic Systems Projects Office (SSPO) equipment and HM&E equipment not grouped by LAPL numbers, are grouped by the first five positions of the APL number (i.e., CAT ID). There were 18,257 MFRF's for these types of equipments.

The MFRF file contains information on groupings, either LAPL, CID, or CAT ID, on family name and on the numerical value of the MFRF. A sample of each type is given in Table 3.

In discussions with the NAVSUP sponsors it was decided first to examine the HM&E MFRF's grouped by LAPL number because the MFRF's grouped by LAPL's are the largest section of the MFRF file and because they cover the broadest range of equipment. Accordingly, the HM&E MFRF's were sorted alphabetcally to facilitate comparisons with the GIDEP and RAC data.

The GIDEP failure rate data are provided in units of failures per million operating hours. The BRF and MFRF data are in units of replacements per installation per year. A typical piece of equipment was assumed to operate 6000 hours per year. Multiplying the GIDEP failure rate by 6000 hours per year converts the GIDEP rate into a rate in units of failures per year.

GIDEP lists data for many observed environments, but for purposes of this study all MFRF data are assumed to be for shipboard use. Therefore, it is often necessary to convert GIDEP data from one environment to another. Environmental conversion factors, commonly called K-factors, are available. The K-factors listed in Table 4 were extracted from a GIDEP manual [4] for use in this analysis.

TABLE 3 - SAMPLE MFRF DATA

TABLE 3A - LAPL

LAPL	NOMENCLATURE	MFRF
01-002	STEAM CHEST	.0096
01-002	STEM	.0760
01-002	STEM ASSY	.0580
01-002	STEM WITH SEAT	.0645
01-002	STRIP	.3000
01-002	STUD	.1800
01-002	SUCTION	.0400
01-002	TAIL ROD	.0640
01-002	TAPPET	.0840
01-002	THERMOMETER	.2000
01-002	TIE ROD	.0250
01-002	TOOL	.0620
01-002	TUBE	.1600
01-002	UNIONXPIPE	.7100
01-002	VALVE	.0810
01-002	VALVE ASSY	.0420
01-002	VALVE KIT	.0500
01-002	VALVE UNIT	.0430
01-002	VENT	0.0000
01-002	WASHER	.0660
01-002	WING VALVE	.1100
01-002	WIPER	1.0000
01-002	WIRE	.1200
01-002	WORM	0.0000
01-002	WRENCH	.0800
01-003		.1700
01-003	ADAPTER	.0470
01-003	ASBESTOS SHEET	.2000
01-003	BEARING	.1500
01-003	BEARING ASSY	.0800
01-003	BEARING HALF SET	.1500
01-003	BEARING SET	.0795
01-003	BELT	.2700
01-003	BOLT	.0900
01-003	BUSHING	.1050
01-003	CAP	.0480
01-003	CASE	0.0000
01-003	CASING	.5100
01-003	CLAMP	.0350
01-003	COCK	1.0800

TABLE 3 (Continued)

TABLE 3B - CID

CID	NOMENCLATURE	MFRF
002	ACCELERATOR	.2500
002	ACCUMULATOR	.0225
002	ACTIVATOR	.0079
002	ACTUATOR	.0410
002	ACTUATOR ASSY	.0041
002	ADAPTER	.1300
002	ADAPTER ASSY	.1000
002	AMMUNITION	.3000
002	AMPLIFIER	.0099
002	ANCHOR	.1000
002	ANVIL	.1200
002	ARBOR	.0071
002	ARM	.0380
002	ARMAMENT	.0570
002	ARMAMENT SUBSYSTEM	.0130
002	ARMATURE	.0009
002	AXLE	.0340
002	AXLE BLOCK	.0290
002	BAFFLE	.2570
002	BAG	.2000
002	BALL	.0013
002	BAR	.1550
002	BARREL	.2200
002	BARREL ASSY	.0575
002	BASE	.0360
002	BASE ASSY	.0290
002	BATTERY	.0750
002	BEAM	.1500
002	BEARING	.1000
002	BEARING UNIT	.0095
002	BIN	.2500
002	BLADE	.1300
002	BLAST	.0220
002	BLOCK	.0290
002	BOAT	.4500
002	BODY	.2000
002	BODY ASSY	.0190
002	BOLT	.0995
002	BOLT ASSY	.1600
002	BOOSTER	.0650

TABLE 3 (Continued)

TABLE 3C - CAT ID

CAT ID	NOMENCLATURE	MFRF
01513	SHAFT	.1000
01513	SHOE	.1600
01513	SLINGER	.0470
01513	SPACER	.2500
01513	SPINDLE	.0965
01513	SPRING	.1132
01513	STEM	.1320
01513	STRAINER	.0300
01513	STUD	.0059
01513	STUFFING BOX	.2000
01513	VALVE	.0600
01513	VALVE SEAT	.0340
01513	WASHER	.0740
01513	WEIGHT	.0250
01515	ADAPTER	.1000
01515	BEARING	.1632
01515	BEARING ASSY	.0800
01515	BOLT	.1000
01515	COVER	.4030
01515	COVER ASSY	.4000
01515	GASKET	.0800
01515	IMPELLER	.0430
01515	INSERT	.1600
01515	JUMPER	.0200
01515	KEY	.0625
01515	LOCK	.0570
01515	LOCKING CUP	.0600
01515	LOCKING PLATE	.0410
01515	NUT	.0800
01515	PACKING	1.0000
01515	PIN	.0800
01515	PUMP	.0095
01515	PUMP UNIT	.0180
01515	ROTOR	.1000
01515	SCREW	.0600
01515	SEAL PLATE	.0800
01515	SETSCREW	.0630
01515	STATOR	.0095
01515	STUD	.4000
01515	TUBE	.1700

TABLE 4 - K-FACTORS

Environment	Abbreviation	K-factor
Ground, Fixed	GND	1.0
Ground, Mobile	MBL	1.5
Airborne, Flight	AC, Air, Helo, Jet	2.5
Shipboard	SHP, SUB	2.5

For example, the GIDEP failure rate for Bearing, Radial in a ground mobile environment is 5.13 failures per million hours. To convert this failure rate to a replacement rate per year in a shipboard environment, the conversion factors are applied as follows:

$$\text{Rate} = \left(5.13 \ \frac{\text{Failures}}{10^6 \text{ hours}}\right)\left(6 \times 10^3 \ \frac{\text{hours}}{\text{year}}\right)\left(\frac{\text{2.5 K-factor (Ship)}}{\text{1.5 K-factor (Ground, Mobile)}}\right)$$

$$= .0513 \ \frac{\text{Failures}}{\text{Year}}$$

5.2 INITIAL EVALUATION

To determine the range of coverage, well defined families were selected from the MFRF listing and the GIDEP and RAC manuals were checked for comparable data. A family is defined as the name of an item which appears in a LAPL. Families such as bearing, bushing, gear, shaft, and valve were selected for analysis. The GIDEP manual used was the Summary of Failure Rate Data, Volume II, of October 1976. The RAC data chosen for the analysis were taken from the Nonelectronics Parts Reliability Data Handbook (NPRD-1). It was felt that this type of data was more applicable to HM&E equipment than the detailed microcircuit RAC data.

Results of the search indicated that GIDEP or RAC data were available for approximately 75% of the selected MFRF families, but it quickly became apparent that the selection of well defined families prejudiced the range of coverage. Although more MFRF families had to be examined, it did not appear feasible to search the entire MFRF file. It was decided initially to evaluate the range of coverage for all families

beginning with the letters A and P. These families were chosen simply because they are at the beginning and approximately the middle of the sorted MFRF file.

5.2.1 All Families Starting with the Letter A.

The MFRF file by LAPL number contained 154 families beginning with the letter A. Family size is defined as the number of occurrences of the same name in the MFRF listing. For example, if MFRF's for the name "adapter" appear in ten LAPL's, its family size is ten. MFRF family size is summarized in Table 5.

TABLE 5 - SIZE OF FAMILIES STARTING WITH THE LETTER A

Family Size	Number of Occurrences
1	78
2	24
3	7
4	10
5	4
6-10	10
11+	21
Total	154

Comparison with the GIDEP data provided data for ten families; 144 MFRF families had no GIDEP data. Inspection of the families without data showed that many were very small (i.e., the name appeared in only 5 or fewer LAPL's). The list of families starting with the letter A that have GIDEP data and the family size of each is given in Table 6.

TABLE 6 - FAMILY SIZE OF FAMILIES STARTING WITH THE LETTER A THAT HAVE GIDEP DATA

FAMILY NAME	FAMILY SIZE
Accelerometer	3
Accumulator	17
Actuator	48
Adapter	258
Alternator	4
Ammeter	50
Amplifier	76
Antenna	9
Arms	91
Atomizer	3

Of the 31 MFRF families with family size greater than 5, seven had GIDEP data. Only 3 of the 123 families with family size less than 5 had GIDEP data. Seven of the 10 families that had GIDEP data had a family size greater than 5.

5.2.2 All Families Starting with the Letter P

A total of 380 alphabetic MFRF families began with P. The MFRF family size breakdown for all families starting with the letter P is given in Table 7.

TABLE 7 - SIZE OF FAMILIES STARTING WITH THE LETTER P

Family Size	Number of Occurrences
1	199
2	55
3	22
4	16
5	6
6-10	19
11+	63
TOTAL	380

Ten of these families had GIDEP data, as shown in Table 8.

TABLE 8 - FAMILY SIZE OF FAMILIES STARTING WITH THE LETTER P THAT HAVE GIDEP DATA

FAMILY NAME	FAMILY SIZE
Panel	58
Pins	334
Pipe	59
Piston	135
Plastic	70
Power Supply	12
Programmer	1
Projector	4
Protector	57
Pump	133

Of the 82 MFRF families with family size greater than five, 8 had GIDEP data; only two of the 298 families with family size of 5 or less had GIDEP data. Eight of the 10 families with GIDEP data had a family size greater than 5.

Analysis of these two samples indicated that most of the families are small and that GIDEP data is more likely to be available for families that are large. Therefore it was decided to analyze the MFRF file grouped by LAPL's by family size.

It should be noted that a small family size does not mean that the family has a small parts population. A name may appear in only one LAPL but there might be many items in use (a large population); conversely, a name may appear in many LAPL's but there may be only a few items in use.

5.3 ANALYSIS OF FAMILY SIZE

The MFRF file for HM&E equipment grouped by LAPL number was sorted alphabetically and the number of occurrences of each name was counted to obtain family sizes. Table 9 summarizes the number of families of

each size and the number of MFRF's in each family size category. Also shown is the percent of the total number of families represented by each family size and the cumulative percent of this figure. The percent of the total number of MFRF's in each family size category and the cumulative percent is also shown.

TABLE 9 - MFRF BREAKDOWN BY FAMILY SIZE

Family Size	Number of Families	MFRF's	% of Families	Cum % of Families	% of MFRF's	Cum % of MFRF's
1	2703	2703	55.1	55.1	6.1	6.1
2	662	1324	13.5	68.6	3.0	9.1
3	323	969	6.6	75.2	2.2	11.3
4	206	824	4.2	79.4	1.9	13.2
5	133	665	2.7	82.1	1.5	14.7
6-10	331	2587	6.7	88.8	5.8	20.5
11+	552	35333	11.2	100.0	79.5	100.0
TOTAL	4910	44405				

This table shows that 17.9 % of the families have size greater than 5 and contain 85.3% of the MFRF's. The distribution of family size and of MFRF's by family size is presented graphically in Figure 1. The distribution of family size for large families is given in Table 10.

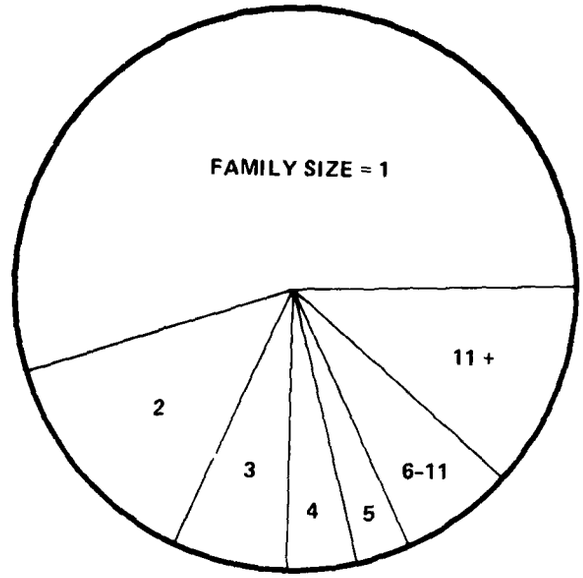

Figure 1a - Distribution of Family Size

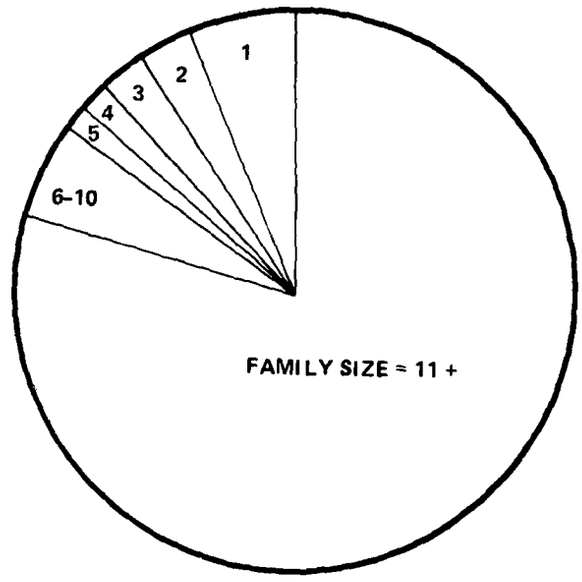

Figure 1b - Distribution of MFRF's by Family Size

Figure 1 - Family Size Distribution

TABLE 10 - FAMILY SIZE DISTRIBUTION OF LARGE FAMILIES

Family Size	Number of Families
6-25	561
26-50	131
51-100	91
100+	100 *
TOTAL	883

*173 MFRF's in the listing did not have a name and were grouped together as one large family which was not analyzed.

Since as previously shown the larger families are more likely to have GIDEP data, these larger families were the ones selected for detailed analysis. It was decided to examine first all families with a family size greater than 100 and then to select a random sample of families with a family size between 6 and 25, inclusive. To aid in this analysis, computer programs were developed to calculate the median, mean, and standard deviations of the MFRF data for all families to be considered in the analysis.

5.4 FAMILY SIZE GREATER THAN 100

MFRF data for 99 valid families with a family size greater than 100 were compared with the GIDEP and RAC data to determine the range of coverage and the percentage differences in the rates. When more than one GIDEP or RAC rate was listed, the number closest in value to the MFRF mean or median rate was used. This biased the percentage difference toward the GIDEP or RAC data. Appendix A contains the data used in this analysis.

Percent difference intervals were established and the number of rates in each interval was counted and the percent of the rates in each interval calculated. The GIDEP and RAC data are compared with the median value of the MFRF data in Table 11 and with the mean value of the MFRF data in Table 12. The data are presented graphically for the GIDEP data in Figure 2 and for the RAC data in Figure 3.

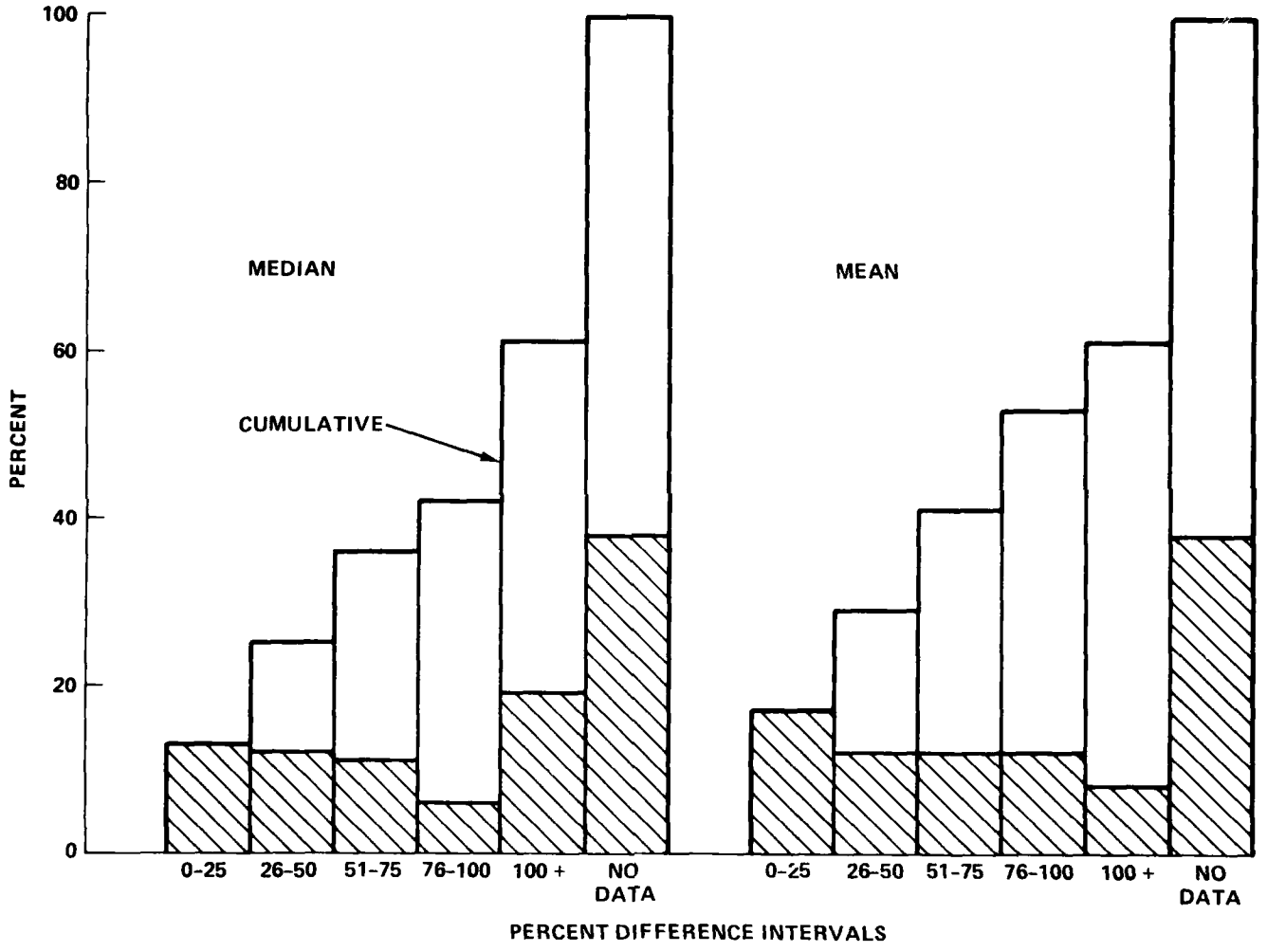

Figure 2 - Comparison of GIDEP Data with MFRF Data for Family Size Greater Than 100

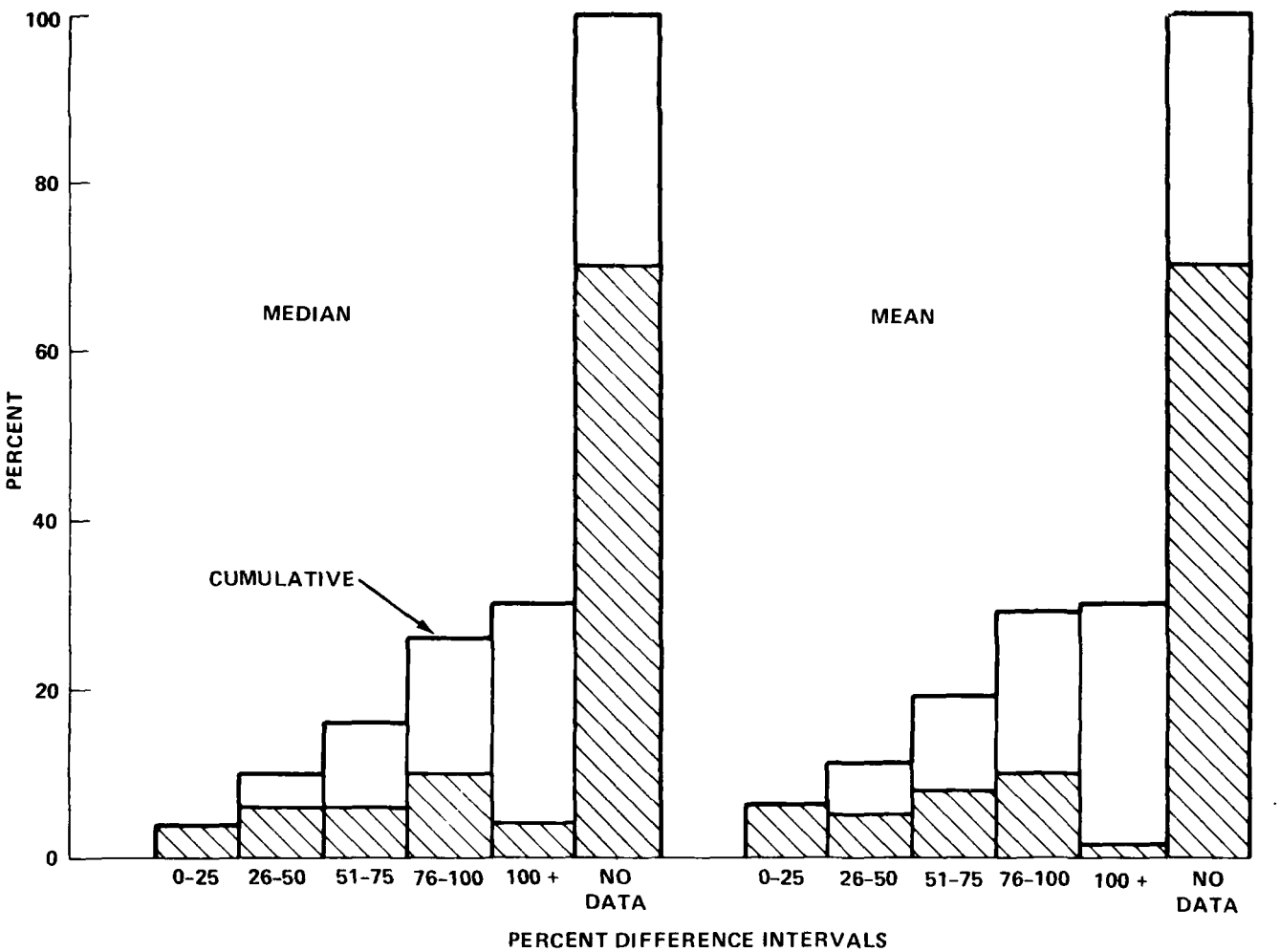

Figure 3 - Comparison of RAC Data with MFRF Data for Family Size Greater Than 100

TABLE 11 - COMPARISON WITH MFRF MEDIAN (FAMILY SIZE GREATER THAN 100)

Percent Difference From MFRF Median	GIDEP %	GIDEP Cum	RAC %	RAC Cum
0-25%	13	13	4	4
26-50%	12	25	6	10
51-75%	11	36	6	16
76-100%	6	42	10	26
100+%	19	61	4	30
No Data	39	100	70	100

TABLE 12 - COMPARISON WITH MFRF MEAN (FAMILY SIZE GREATER THAN 100)

Percent Difference From MFRF Mean	GIDEP %	GIDEP Cum	RAC %	RAC Cum
0-25%	17	17	6	6
26-50%	12	29	5	11
51-75%	12	41	9	20
76-100%	12	53	10	30
100+%	8	61	0	30
No data	39	100	70	100

The GIDEP data base contained data for 61% of the large MFRF families and the RAC data base for 30%. Twenty-five percent of the GIDEP rates were within 50% of the MFRF median and 29% were within 50% of the MFRF mean. Only about 10% of the RAC data were within 50% of the MFRF values. Since the comparison is for the largest MFRF families, the range of coverage of the GIDEP and RAC data should be larger than for MFRF families with a smaller family size.

5.5 FAMILY SIZE OF 6 to 25

There are 561 families in the group of families with a family size of 6 to 25. A sample composed of 46 families was constructed by selecting two families from each alphabetic letter, when possible. The results

of analyzing this sample are shown in Tables 13 and 14, and in Figures 4 and 5. Appendix B contains the data used in this analysis.

TABLE 13 - COMPARISON WITH MFRF MEDIAN (FAMILY SIZE 6 TO 25)

Percent Difference From MFRF Meadian	GIDEP %	GIDEP Cum	RAC %	RAC Cum
0-25%	0	0	0	0
26-50%	2	2	2	2
51-75%	4	6	0	2
76-100%	0	6	0	2
100+%	9	15	2	4
No Data	85	100	96	100

TABLE 14 - COMPARISON WITH MFRF MEAN (FAMILY SIZE 6 TO 25)

Percent Difference From MFRF Mean	GIDEP %	GIDEP Cum	RAC %	RAC Cum
0-25%	2	2	2	2
26-50%	7	9	0	2
51-75%	0	9	2	4
76-100%	0	9	0	4
100+%	7	16	0	4
No data	84	100	96	100

The method of comparison was the same as for the families of size greater than 100. The GIDEP data base contained data for only 15% of the MFRF families and the RAC data base for only 4%. This result further suggests that the range of coverage decreases as the family size decreases.

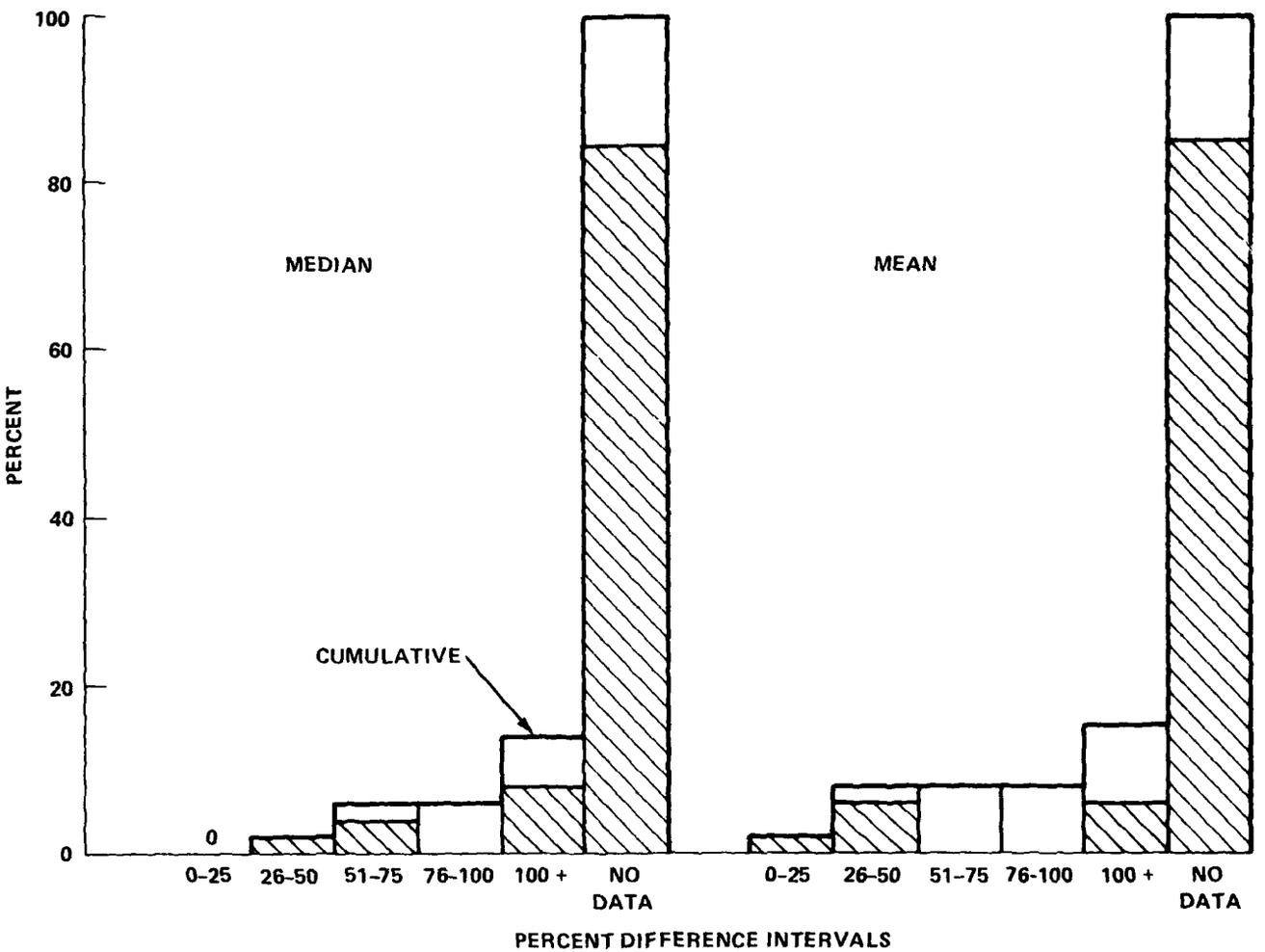

Figure 4 - Comparison of GIDEP Data with MFRF Data for Family Size of 6 to 25

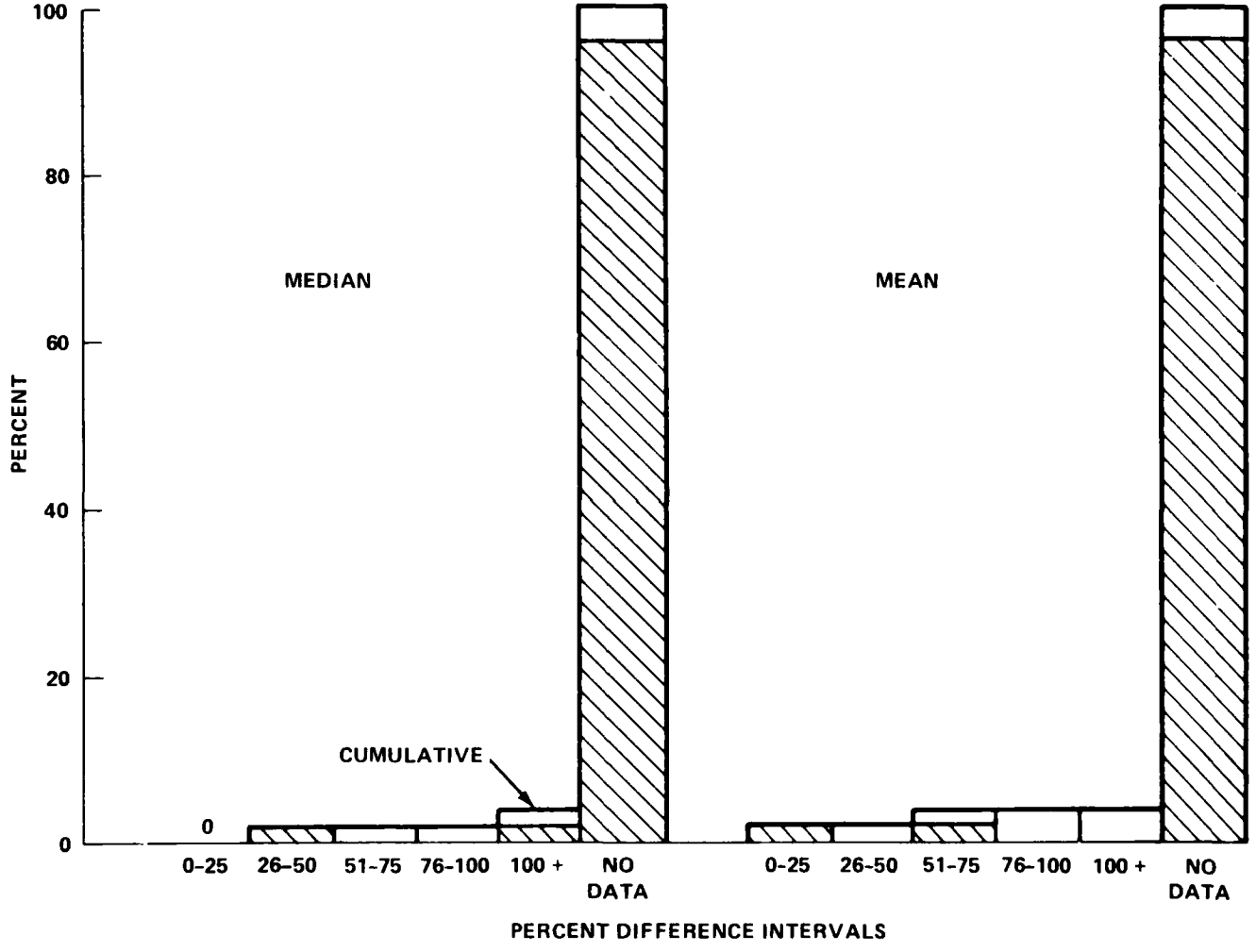

Figure 5 - Comparison of RAC Data with MFRF Data for Family Size of 6 to 25

5.6 RESULTS OF MFRF, GIDEP, AND RAC COMPARISON

Comparison of the GIDEP, RAC, and MFRF data bases for range of coverage and differences between the rates showed that

- The range of coverage of the GIDEP and RAC data bases is not as comprehensive as the range of coverage of the MFRF data base for Navy HM&E equipment;
- Navy HM&E equipment covered by the GIDEP and RAC data bases includes for the most part established items for which MFRF data are already available;
- The MFRF, GIDEP, and RAC data bases must be compared with actual usage or demand data to determine the quality of the rates and to assess whether the GIDEP and RAC data may be used to improve the quality of some initial replacement rates.

SECTION 6
COMPARISON OF MFRF, GIDEP, AND RAC DATA WITH 3M DATA

The comparison of the GIDEP and RAC data with the MFRF data showed that the range of coverage of the MFRF data was much greater than that of either the GIDEP or the RAC data and that the values of the rates differed. Since the analysis up to this point did not determine which was the more accurate rate, it was decided to compare data from the different data bases with 3M data to see which of the data bases compares most closely with operational data.

6.1 SOURCE OF 3M DATA

The 1977 BRF master file provided by SPCC was the source of 3M data. A sample of this file is shown in TABLE 15. The BRF for each stock number is updated annually using the 3M population and 3M usage data elements of the master file. For our analysis we defined the 3M usage rate as the ratio of the usage to the population. Only stock numbers whose BRF's had never been updated were extracted from the file and the 3M usage rate was calculated. Specific families were selected for evaluation and their mean and median 3M usage rates were calculated. It was with these values that the MFRF, GIDEP, and RAC replacement rates were compared.

6.2 SELECTION OF FAMILIES FOR ANALYSIS

The families selected for analysis were those with family size greater than 100, as described in the previous section. 3M usage rates were developed for 48 of these 99 families. The mean and median 3M rates were calculated and compared with the MFRF, GIDEP, and RAC data developed in Section 5. The criterion used for comparison was the percentage difference between the 3M usage rate and each of the other replacement rates. After each percentage difference had been calculated, values were grouped in 0-25%, 26-50%, 51-75%, 76-100%, 100 +%, and no data intervals and the percentage of the rates occurring in each interval was calculated.

TABLE 15 - SAMPLE BRF DATA

NIIN	FSC	CCG	UI	NOMENCLATURE	PRICE	I	POP	3-M USAGE	POP	SHF USAGE	POP	SYSTEM DEMAND	BRF	DATE	CODE	INV	N.BRF	RATIO	C
005295919	4820	2H	EA	VALVE,BALL	848.00		15.	0.	0.	0.	17.	0.	.0070	69150	3M	.00	.0042	.60	
005295920	5310	4Z	EA	WASHER,FLAT	11.54		32.	4.	0.	0.	38.	0.	.0360	73060	3M	.00	.0890	2.48	
005295922	4820	9C	EA	BALL,VALVE	107.15		45.	0.	0.	0.	64.	0.	.0135	73060	3M	.00	.0081	.60	
005295924	4820	2H	EA	VALVE,BALL	357.00		16.	0.	0.	0.	32.	0.	0.0000	69171	3M	.00	0.0000	0.00	N
005295926	4820	2H	EA	VALVE,BALL	967.00		23.	0.	0.	0.	24.	0.	0.0000	69150	3M	.00	0.0000	0.00	N
005295927	4820	2H	EA	VALVE,BALL	1030.00		6.	0.	0.	0.	6.	0.	0.0000	69150	3M	.00	0.0000	0.00	N
005295928	4820	9C	EA	SEAT,VALVE,NONMETAL	29.82		32.	4.	0.	0.	38.	0.	.0541	73060	3M	.00	.0970	1.78	
005295929	4820	9C	EA	BALL,VALVE	621.92		16.	0.	0.	0.	19.	0.	.0064	73060	3M	.00	.0038	.59	
005295930	4820	9C	EA	BALL,VALVE	35.60		8.	0.	0.	0.	21.	0.	.0090	73060	3M	.00	.0054	.60	
005295931	4820	9C	EA	STEM,VALVE	68.74		16.	0.	0.	0.	42.	0.	.0275	73060	3M	.00	.0170	.60	
005295932	5315	9C	EA	PIN,STRAIGHT,HEADLE	.54		230.	0.	0.	0.	359.	0.	.0313	73060	3M	.00	.0190	.60	
005295933	4820	2H	EA	VALVE,BALL	273.00		5.	0.	0.	0.	12.	0.	0.0000	69150	3M	.00	0.0000	0.00	N
005295935	4820	2H	EA	VALVE,BALL	377.00		2.	0.	0.	0.	2.	0.	0.0000	69150	3M	.00	0.0000	0.00	N
005295936	4820	2H	EA	VALVE,BALL	1640.00		8.	0.	0.	0.	19.	0.	.0489	69150	3M	.00	.0290	.59	
005295937	4820	2H	EA	VALVE,BALL	1950.00		16.	0.	0.	0.	19.	0.	0.0000	69150	3M	.00	0.0000	0.00	N
005295938	4820	9C	EA	STEM,VALVE	226.00		36.	0.	0.	0.	58.	0.	.0067	73060	3M	.00	.0040	.59	
005295939	5330	9Z	EA	GASKET	6.53		159.	0.	0.	0.	318.	0.	.0887	73060	3M	.00	.0530	.59	
005295940	4820	9C	EA	BALL,VALVE	112.20		36.	0.	0.	0.	58.	0.	.0264	73050	3M	.00	.0160	.59	
005295941	5930	9N	EA	SWITCH,SENSITIVE	58.24		333.	1.	0.	0.	431.	0.	.0435	73060	3M	.00	.0270	.62	
005295947	2825	1H	SE	BLADING SET,TURBINE	2210.00		0.	0.	0.	0.	32.	0.	.0046	62001	SY	.00	.0028	.60	
005295949	4530	9C	EA	DEFLECTOR,DIRT AND	93.97		2.	0.	0.	0.	7.	0.	.1999	73050	3M	.00	.1600	.79	
005295950	4530	9C	EA	PLATE,SPRAYER,OIL B	7.24		6.	0.	0.	0.	21.	0.	.0958	73060	3M	.00	.0580	.60	
005295952	4530	9C	EA	PLATE,SPRAYER,OIL B	5.76		2.	0.	0.	0.	7.	0.	.1999	73050	3M	.00	.1600	.79	
005295953	2030	1H	EA	PISTON,HYDRAULIC AC	75.00		48.	0.	0.	0.	60.	0.	.0062	61191	3M	.00	.0037	.59	
005295957	5360	9Z	EA	SPRING,HELICAL,COMP	18.72		16.	16.	0.	0.	24.	0.	0.0000	74244	NO-REV	.00	0.0000	1.00	N
005295958	2825	1H	SE	BLADING SET,TURBINE	1670.00		64.	0.	0.	0.	72.	0.	0.0000	62001	3M	.00	0.0000	0.00	N
005295961	4320	9C	EA	SHAFT,SHOULDERED	111.28		256.	3.	0.	0.	432.	0.	.0144	73060	3M	.00	.0130	.92	
005295962	4320	9C	EA	IDLER ASSEMBLY	24.06		60.	0.	0.	0.	108.	0.	.0023	73050	3M	.00	.0014	.60	
005295964	2825	1H	EA	PISTON,OVERSPEED VA	194.00		122.	0.	0.	0.	202.	44.	.0072	62001	3M	.00	.0043	.59	
005295965	2825	1H	EA	SHAFT,PRESSURE TRIP	79.00		64.	1.	0.	0.	72.	10.	.0029	62001	3M	.00	.0110	3.62	
005295966	2825	1H	SE	SHIELD,WINDAGE	2040.00		64.	0.	0.	0.	72.	4.	.0013	62001	3M	.00	.0008	.61	
005295967	4320	9C	EA	PUMP,ROTARY	4180.84		60.	0.	0.	0.	68.	0.	0.0000	74001	3M	.00	0.0000	0.00	N
005295970	3120	9Z	EA	BEARING HALF,SLEEVE	358.80		0.	0.	0.	0.	8.	0.	1.0000	73060	NO-DAT	.00	1.0000	1.00	N
005295971	6685	9G	AY	BELLOWS ASSEMBLY	189.28		314.	42.	0.	0.	581.	0.	.4389	73060	NO-DAT	.37	.4400	1.00	N
005295972	4310	1H	EA	CRANKSHAFT,COMPRESS	1710.00		4.	0.	0.	0.	7.	0.	.0085	61191	3M	.00	.0068	.80	
005295974	4330	9C	EA	DISK,TOP	99.98		92.	0.	0.	0.	600.	0.	.0101	73060	3M	.00	.0061	.60	
005295976	4310	9C	AY	CYLINDER ASSEMBLY,R	1256.48		10.	0.	0.	0.	19.	0.	.0384	73060	3M	.00	.0230	.59	
005295977	4730	9C	EA	STRAINER ELEMENT,SE	7.17		162.	0.	0.	0.	466.	0.	.0748	73050	3M	.00	.0450	.60	
005295978	2825	1H	EA	NOZZLE BLOCK,TURBIN	704.00		34.	0.	0.	0.	58.	0.	0.0000	62001	3M	.00	0.0000	0.00	N
005295979	4320	1H	EA	PUMP,ROTARY	549.00		32.	0.	0.	0.	40.	1.	.0156	62001	3M	.00	.0094	.60	

6.3 COMPARISON OF RATES

The data are tabulated in Tables 16 and 17 and presented graphically in Figures 6, 7, and 8. The data used in the analysis are given in Appendix C.

TABLE 16 - PERCENT DIFFERENCE OF MEAN RATES

Interval	MFRF	Cum	GIDEP	Cum	RAC	Cum
0-25 %	15	15	19	19	2	2
26-50 %	19	34	6	25	8	10
51-75 %	15	49	21	46	8	18
76-100%	36	85	31	77	25	43
100+%	15	100	13	90	2	45
No Data	0	100	10	100	55	100

TABLE 17 - PERCENT DIFFERENCE OF MEDIAN RATES

Interval	MFRF	Cum	GIDEP	Cum	RAC	Cum
0-25 %	17	17	23	23	8	8
26-50 %	21	38	23	46	6	14
51-75 %	21	59	8	54	8	22
76-100%	24	83	15	69	17	39
100+%	17	100	21	90	6	45
No Data	0	100	10	100	55	100

The MFRF data covered 100% of the 3M families, the GIDEP data 90%, and the RAC data 45%. Thirty-four percent of the mean MFRF's were within 50% of the mean 3M rate and 38% of the median MFRF's were within 50% of the median 3M rate. For GIDEP 25% were within 50% of the 3M mean and 46% within 50% of the 3M median. The corresponding percentages for RAC were 10% and 14%.

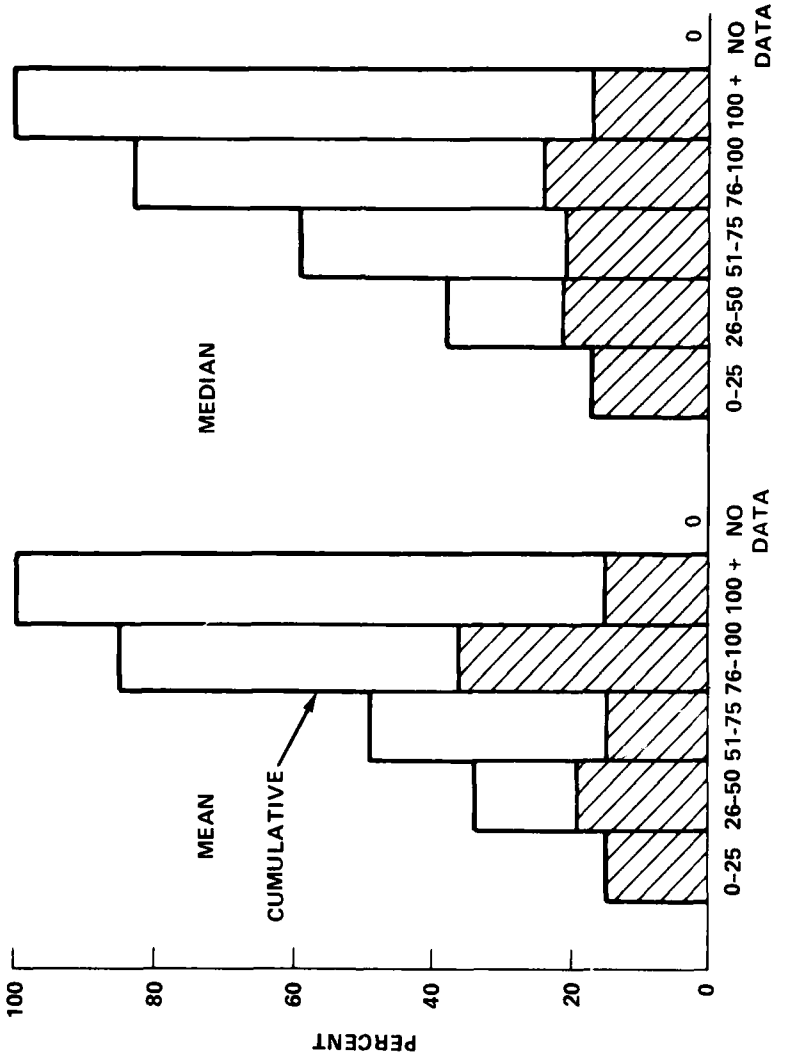

Figure 6 - Comparison of MFRF Data with 3M Data

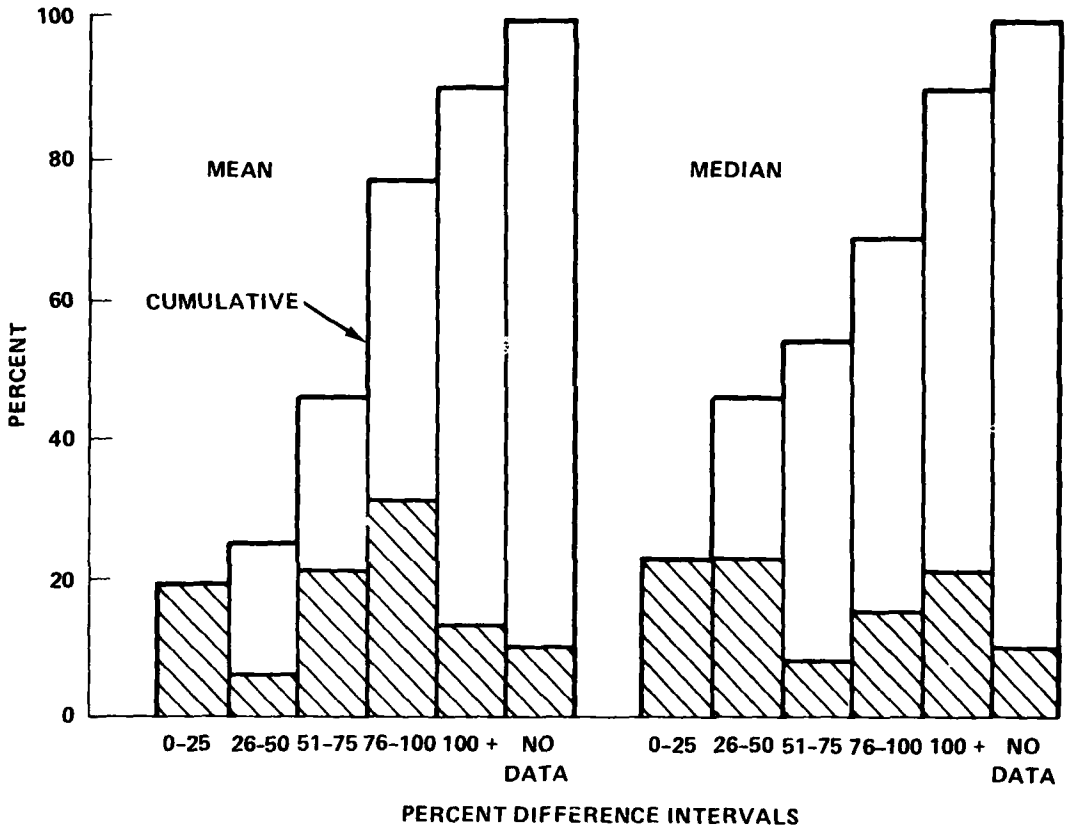

Figure 7 - Comparison of GIDEP Data with 3M Data

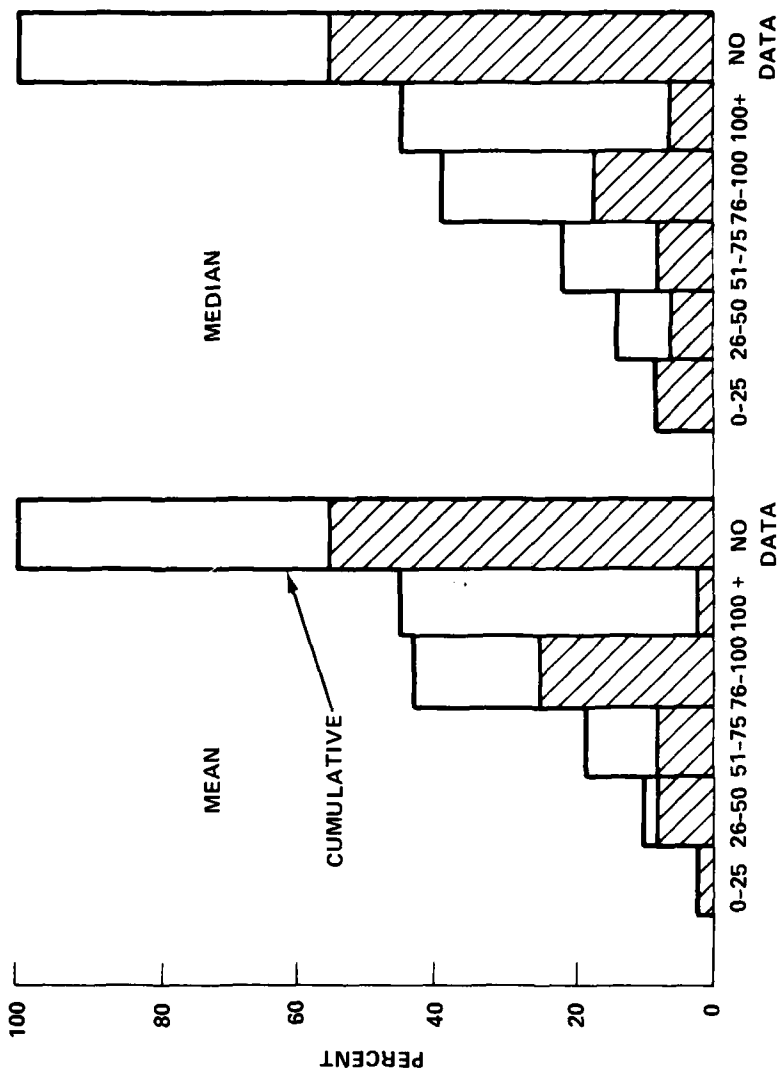

Figure 8 - Comparison of RAC Data with 3M Data

6.4 RESULTS OF COMPARISON

Examination of the data leads to the following observations:

- RAC contained data for less than half of the 3M families; GIDEP for 90%.

- The comparison of the distributions of the MFRF and GIDEP percentage differences shows that there is little overall difference and that the MFRF and GIDEP data bases are considered to compare equally to operational data.

SECTION 7
ANALYSIS OF SELECTED STOCK NUMBERS

7.1 SELECTION OF STOCK NUMBERS

To explore how the different data bases compare to a sample of stock numbers, NAVSUP acquired a list of stock numbers from the Casualty Reporting (CASREPT) System. These stock numbers had no replacement rate data in the supply system, which led to difficulties in reordering. The list contained 62 stock numbers, all for items from equipment aboard the FF 1060 and LST 1196. Data provided included APL numbers, cognizance Code (COG), and stock number.

7.2 ACQUISITION OF DATA

In order to determine the coverage of the items, the following data sources were surveyed:

- APL - checked to determine whether the items were included
- BASIC NAVY - nomenclature was found in the Management Data List, Navy 0-268/79
- BRF - replacement rates extracted from the 1977 BRF master file
- MFRF - replacement rates extracted from the 1977 MFRF File
- GIDEP - replacement rates calculated from the GIDEP data base
- RAC - replacement rates calculated from the RAC nonelectronics reliability data.

7.3 COVERAGE

The data are given in Appendix D. The results are summarized in Table 18.

TABLE 18 - COVERAGE OF SELECTED STOCK NUMBERS

	FF 1060		LST 1196		Combined	
Data Source	Data	No Data	Data	No Data	Data	No Data
BRF	33	15	14	0	47	15
MFRF	47	1	12	2	59	3
GIDEP	29	19	6	8	35	27
RAC	23	25	5	9	28	34

Only a few of the stock numbers were listed in an APL, indicating that most of the items are not normally stocked aboard ship. Forty-seven of the stock numbers had BRF's. Of the 15 stock numbers that did not have BRF's, all had MFRF's, eight had GIDEP rates, and 5 had RAC rates. The range of coverage of the MFRF data base was 95%, of the GIDEP data base 56%, and of the RAC data base 45%.

SECTION 8
SUMMARY OF RESULTS

An evaluation matrix was used to assess the results of the different comparisons of the data bases. Numerical ratings were assigned to each data base according to the following criteria:

- Range of coverage of items with family size greater than 100 (common items)
- Range of coverage of items with family size between 6 and 25 (uncommon items)
- Comparison to 3M usage data
- Coverage of selected stock numbers

Numerical values were developed from the tables in the preceding sections as follows:

- The MFRF data base provides the greatest coverage for both common and uncommon items; therefore, it was assigned a rating of 100 for each element of the matrix. The GIDEP data base covers approximately 60% of the common items that the MFRF data base covers and about 15% of the uncommon items; therefore, the GIDEP rating is 60 and 15. Similarly, the RAC rating is 30 and 5.
- The MFRF and GIDEP data bases compare almost equally to 3M usage data; therefore, both were assigned ratings of 100. Approximately one-third of the RAC rates correlate at the same level as the MFRF and GIDEP rates, so RAC was assigned a value of 30.
- The MFRF data base covered all the selected stock numbers, GIDEP approximately half the items, and RAC approximately one-third. The ratings assigned were 100, 50, and 30, respectively.

The evaluation matrix is shown in Table 19.

TABLE 19 - EVALUATION MATRIX

Criteria	MFRF	GIDEP	RAC
Coverage of Common Items	100	60	30
Coverage of Uncommon Items	100	15	5
Comparison to 3M Data	100	100	30
Coverage of Selected Items	100	50	30
TOTALS	400	225	95

The most important conclusion drawn from this study is that the MFRF data base has a greater coverage than the other data bases examined and correlates as closely to operational data as the other data bases; therefore, supplementing the MFRF data base with GIDEP or RAC data does not appear to offer an improvement in the capability to provide initial replacement rates for Navy HM&E equipment.

The question, then, is whether or not the GIDEP and RAC data bases are useful to the Navy for initial provisioning. If the Navy already has an initial replacement rate for an item, the GIDEP or RAC data are not needed. If the Navy does not have an initial replacement rate for an item, the GIDEP or RAC data bases might provide one.

APPENDIX A

MFRF, GIDEP, AND RAC DATA
FAMILY SIZE GREATER THAN 100

MFRF, GIDEP, AND RAC DATA, FAMILY SIZE GREATER THAN 100

Family Name	Family Size	MFRF Data		GIDEP Data				RAC Data			
		Median	Mean	Envir	Rate	Percent Median	Percent Mean	Envir	Rate	Percent Median	Percent Mean
Adapter	255	0.0460	0.1581	LAB HELO	0.0781 0.1309	70	17				
Asbestos Sheet	242	0.1880	0.1811								
Ball	189	0.0420	0.0784								
Bearing	497	0.0605	0.0893	MBL HELO	0.0513 0.0726	15	19	SUB	0.0284	53	68
Belt	187	0.2800	0.3281	GND	0.0121	96	96				
Block	102	0.0235	0.0652								
Body	115	0.0260	0.0825								
Bolt	217	0.0610	0.2229	MBL	0.0275	55	88				
Brush	142	0.1005	0.2624					AIR	0.0285	128	89
Bushing	317	0.0540	0.1224	MBL	0.0477	12	17	HELO	0.1269	135	4
Cap	199	0.0304	0.1766	MBL	0.0151	50	91				
Capacitor	224	0.0118	0.0520	SUB LAB	0.0134 0.0769	13	48				
Chain	121	0.0400	0.0736								
Circuit	131	0.0320	0.0614	GND MBL	0.0198 0.0533	38	13	GND	0.0432	35	30
Clamp	167	0.0196	0.1166	MBL	0.0275	40	76				
Clip	129	0.0246	0.0812	LAB	0.1171	376	44				
Coil	249	0.0320	0.0567	LAB	0.0131	59	77				
Collar	113	0.0230	0.1207								
Connector	264	0.0160	0.0564	LAB MBL	0.0069 0.0877	57	55	MBL	0.0103	36	82
Contact	196	0.0210	0.0676	LAB	2.8302	13376	4086				
Control	153	0.0500	0.0758	SHP GND	0.0183 0.1316	63	74	GND	0.0586	17	23
Cork	117	0.0875	0.1279	HELO	0.7679	777	500				
Coupling	175	0.0420	0.1818	JET	0.1309	211	28	GND	0.0801	91	56
Cover	199	0.0190	0.0534	MBL	0.0995	424	86				
Cup	177	0.0530	0.1031								
Cylinder	114	0.0305	0.1039	MBL MBL	0.0542 0.1084	78	4				
Diaphragm	172	0.1000	0.1616					GND	0.0157	84	90

Family Name	Family Size	MFRF Data		GIDEP Data				RAC Data			
		Median	Mean	Envir	Rate	Percent Median	Percent Mean	Envir	Rate	Percent Median	Percent Mean
Disc	114	0.0240	0.0799								
Disk	223	0.0560	0.1542								
Elbow	110	0.1000	0.2269								
Felt	125	0.1800	0.2201								
Filter	170	0.0480	0.2269	LAB HELO	0.0867 0.2020	95	11	HELO HELO	0.0076 0.2971	84	31
Filter Element	150	0.3800	0.6590								
Fitting	157	0.3600	0.5933	JET JET	0.1309 0.6754	64	14	MBL	0.1303	64	78
Fuse	222	0.4350	0.5585	LAB	0.6250	44	12				
Fuse Holder	108	0.0130	0.0298								
Gage	210	0.1400	0.3023	GND GND	0.1316 0.1584	2	48	GND	0.1234	12	59
Gasket	567	0.1400	0.2091	MBL	0.2203	57	5	SHP	0.0226	84	89
Gear	208	0.0193	0.0364	MBL	0.0324	68	11	GND	0.0025	87	93
Guide	127	0.0450	0.0683								
Handle	113	0.0280	0.1179								
Heater	124	0.0440	0.0739					SUB	0.0456	4	38
Heating Element	124	0.0800	0.1100								
Holder	143	0.0260	0.0602					MBL	0.0002	99	99
Hose	128	0.1300	0.3509	HELO HELO	0.1008 0.2020	22	42	HELO	0.1976	52	44
Hose Assy	113	0.1000	0.1521								
Housing	142	0.0168	0.0398	MBL	0.0603	258	52				
Indicator	159	0.0320	0.0936	SHP GND	0.0183 0.1316	43	41	GND GND	0.0586 0.1254	83	34
Insert	156	0.0460	0.1162								
Insulator	116	0.0280	0.0775								
Key	213	0.0800	0.0962								
Knob	103	0.0146	0.0360								
Lamp	227	0.2200	0.3857	HELO	3.0259	1275	684	SHP	0.1117	49	71

Family Name	Family Size	MFRF Data		GIDEP Data				RAC Data			
		Median	Mean	Envir	Rate	Percent Median	Percent Mean	Envir	Percent Rate	Percent Median	Percent Mean
Lens	109	0.0170	0.0421	AC	0.4932	2801	1071				
Lever	116	0.0175	0.0628	MBL	0.0951	443	51				
Light	157	0.0195	0.0685	HELO	3.0259	15417	4317	GND SHP	0.0041 0.1117	79	63
Link	121	0.0380	0.0695	HELO	0.8143	2043	1072				
Metal	206	0.1300	0.3927								
Motor	205	0.0400	0.0520	MBL	0.0873	118	68	GND GND	0.0185 0.0627	54	21
Nut	394	0.0520	0.2471	MBL	0.0275	47	89				
Packing	594	0.1400	0.1886					GND	0.0529	62	84
Paper	257	0.2250	0.3201								
Parts Kit	221	0.0900	0.2017								
Pin	333	0.0270	0.1063	MBL	0.0254	6	76	GND	0.0002	99	99
Piston	135	0.0380	0.0701	MBL	0.0047	88	93				
Plate	231	0.0310	0.0663								
Plug	284	0.0410	0.0915	MBL	0.0877	114	4				
Plunger	116	0.0400	0.0606								
Pump	133	0.0500	0.0901	SHP	0.0713	43	21	MBL	0.0034	93	96
Relay	258	0.0360	0.0594	SHP	0.0283	21	52	GND	0.0152	58	74
Resistor	248	0.0136	0.0382	GND LAB	0.0182 0.0394	34	3				
Retainer	312	0.0610	0.0936	MBL	0.0027	96	97				
Ring	405	0.0410	0.0722	LAB	0.1195	191	66				
Rod	133	0.0240	0.1004	MBL	0.1512	530	51				
Rotor	114	0.0180	0.0468								
Rubber Sheet	267	0.1500	0.1844								
Screw	341	0.0420	0.1752	MBL	0.0275	35	84				
Seal	431	0.1145	0.1537	MBL MBL	0.0326 0.2203	72	43	GND	0.0734	36	52
Seat	204	0.0391	0.0655								
Semi-Conductor	133	0.0170	0.0566	LAB GND	0.0174 0.0488	2	14				

Family Name	Family Size	MFRF Data		GIDEP Data				RAC Data			
		Median	Mean	Envir	Rate	Percent Median	Percent Mean	Envir	Rate	Percent Median	Percent Mean
Set Screw	175	0.0750	0.2478	MBL	0.0275	63	89				
Shaft	236	0.0195	0.0381	MBL	0.1512	675	297	SUB	0.0404	107	6
Shim	174	0.0413	0.1069	MBL	0.0414	2	61				
Sleeve	176	0.0500	0.1520	MBL MBL	0.1164 0.1604	133	6				
Socket	135	0.0250	0.3213	SHP LAB	0.0002 0.1747	99	46				
Spacer	277	0.0640	0.1466	MBL	0.0414	35	72				
Spring	535	0.0380	0.0666					GND	0.0555	46	17
Stem	124	0.0370	0.0633								
Stud	187	0.0430	0.2321								
Switch	465	0.0370	0.0674	LAB	0.0427	15	37	GND	0.0301	19	55
Terminal	187	0.0084	0.0638	MBL	0.0877	944	37	AC	0.0297	253	53
Ther-mometer	102	0.1950	0.2254	GND	0.0868	55	61				
Trans-former	188	0.0180	0.0480	LAB MBL	0.0195 0.0441	8	8				
Tube	190	0.0500	0.1959	SHP SHP	0.0251 0.2412	50	23				
Valve	365	0.0450	0.0811	SHP	0.0453	1	44	GND GND	0.0252 0.0730	44	10
Washer	464	0.0466	0.0767	MBL	0.0414	11	46				
Window	110	0.0345	0.0672	AC	0.1418	311	111				
Wire	170	0.1500	0.3597	MBL	0.0885	41	75				
Wrench	250	0.0500	0.1705								

APPENDIX B

MFRF, GIDEP, AND RAC DATA
FAMILY SIZE 6 TO 25

MFRF, GIDEP, AND RAC DATA, FAMILY SIZE 6 TO 25

Family Name	Family Size	MFRF Data		GIDEP Data				RAC Data			
		Median	Mean	Envir	Rate	Percent Med	Percent Median	Envir	Rate	Percent Median	Percent Mean
Adapter Assy	10	0.0673	0.0701								
Adjusting Screw	7	0.0160	0.0193	MBL	0.0275	72	43				
Balance	8	0.0260	0.0668								
Band	19	0.0310	0.0590								
Calking	6	0.1500	0.1500								
Carburetor	10	0.1000	0.1020								
Damping	7	0.0080	0.0716								
Desiccant	14	0.3465	0.6266								
Electro-Magnet	6	0.0057	0.0167								
Engine	11	0.0240	0.0390					LAB	0.0135	44	65
File	8	0.2000	0.2334								
Finger	13	0.0470	0.0762								
Gate	6	0.0130	0.0127	LAB	0.0068	48	47				
Gear Shaft	6	0.0143	0.0495	MBL	0.1469	927	197	SUB	0.0404	183	18
Hanger	8	0.0165	0.0224								
Heat Coil	13	0.0210	0.0426								
Igniter	10	0.7500	0.7270	HELO	0.3614	52	50				
Injector	14	0.1115	0.1881								
Jaw	8	0.0035	0.0157								
Joint	25	0.0430	0.1479	JET	0.1309	204	11				
Knuckle	7	0.0185	0.0551								
Knife	19	0.0790	0.1163								
Level	11	0.0345	0.1937								
Lifting	12	0.0060	0.0160								
Magneto	6	0.0205	0.0585								
Mandril	13	0.0120	0.0248								
Network	14	0.0215	0.0350	SHP	1.7429	8007	4880				
Nut Assy	7	0.0800	0.0679								
Oscillator	8	0.0200	0.0428	LAB	0.5412	2606	973				

Family Name	Family Size	MFRF Data		GIDEP Data				RAC Data			
		Median	Mean	Envir	Rate	Percent Median	Percent Mean	Envir	Rate	Percent Median	Percent Mean
Oven	6	0.0238	0.0234								
Pan	11	0.0110	0.3772								
Pillow	8	0.0115	0.0742								
Quadrant	11	0.0230	0.0312								
Quill	8	0.0488	0.0854								
Radiator	6	0.0600	0.0865								
Reamer	17	0.0300	0.1077								
Scraper	18	0.0580	0.1428								
Screw Driver	23	0.6850	0.7764								
Tappet	10	0.0445	0.0504								
Thimble	12	0.0695	0.0902								
Unit	16	0.0535	0.1172								
Universal Joint	6	0.5900	0.4480								
Vent	24	0.0335	0.0412								
Vise	9	0.1000	0.5259								
Wedge	10	0.0335	0.0859								
Wick	25	0.0640	0.1693								

APPENDIX C

COMPARISON OF MFRF, GIDEP, AND RAC DATA WITH 3M DATA

COMPARISON TO MEAN 3M RATE

Family	3M Rate	MFRF Rate	Percent Diff	GIDEP Rate	Percent Diff	RAC Rate	Percent Diff
Adapter	0.2752	0.1581	43	0.0781	72	-	-
Bearing, Ball	0.1121	0.0893	20	0.0726	35	0.0284	75
Belts	0.2371	0.3281	38	0.0121	95	-	-
Bolt, Shear	0.2956	0.2229	25	0.0275	91	-	-
Brush, Elec.	1.0231	0.2624	74	-	-	0.0285	97
Bushing	0.1265	0.1224	3	0.0477	62	0.1269	1
Capacitor, Fxd	0.2935	0.0520	82	0.0164	94	-	-
Circuit Breaker	0.2815	0.0614	78	0.0198	93	0.0432	85
Coil, Rad Freq	0.0163	0.0567	248	0.0131	20	-	-
Connector	0.2574	0.0564	78	0.0877	66	0.0103	96
Contact	0.1075	0.0676	37	2.8302	2533	-	-
Coupling	0.0637	0.1818	185	0.1309	105	0.0801	26
Diaphragm	0.3490	0.1616	54	-	-	0.0157	96
Filter, Fluid	0.4365	0.2269	48	0.2020	54	0.2971	32
Fuse, Cart	3.9191	0.5585	86	0.6250	84	-	-
Gage, Pressure	0.4969	0.3023	39	0.1584	68	0.1254	75
Gasket	0.1975	0.2091	6	0.2203	12	0.0226	89
Gear, Hel	0.0331	0.0364	10	0.0324	2	0.0025	92
Indicator	0.0250	0.0936	274	0.1584	534	0.1254	402
Knob	0.0190	0.0360	89	-	-	-	-
Lamp	2.8893	0.3857	87	3.0259	5	0.1117	96
Lens	2.0063	0.0421	98	0.4932	75	-	-
Light, Indic.	0.1720	0.0685	60	3.0259	1659	0.1117	35

Family	3M Rate	MFRF Rate	Percent Diff	GIDEP Rate	Percent Diff	RAC Rate	Percent Diff
Motor, A.C.	0.2014	0.0520	74	0.0873	57	0.0185	91
Nut	0.0306	0.2471	708	0.0275	10	-	-
Packing	5.5480	0.1886	97	-	-	0.0529	99
Plug	0.0971	0.0915	6	0.1008	4	-	-
Relay, Arm	0.3539	0.0594	83	0.0283	92	0.0055	98
Resistor, Fxd	0.1723	0.0382	78	0.0314	82	-	-
Resistor, Var	0.3587	0.0382	89	0.0394	89	-	-
Ring	4.3964	0.0722	98	0.1195	97	-	-
Ring, Wearing	0.2936	0.0722	75	0.1195	59	-	-
Screw	1.0360	0.1752	83	0.0275	97	-	-
Seal	0.3744	0.1537	59	0.3503	64	0.0734	80
Semiconductor	0.2338	0.0566	76	0.0488	79	-	-
Shaft	0.1295	0.0381	71	0.1512	17	0.0404	69
Shim	2.5278	0.1069	96	0.0414	98	-	-
Sleeve	0.1627	0.1520	7	0.1604	1	-	-
Socket	0.0084	0.3213	3725	0.1747	1980	-	-
Spacer, Ring	0.0622	0.1466	136	0.0414	33	-	-
Spring, Hel	0.1329	0.0666	50	-	-	0.0555	58
Switch, Elec	0.3484	0.0674	81	0.0427	88	0.0301	91
Thermometer	0.1661	0.2254	36	0.0868	48	-	-
Transformer	0.2187	0.0480	78	0.0195	91	-	-
Tube	0.1365	0.1959	44	0.1164	15	-	-
Valve	0.1142	0.0811	29	0.1941	70	0.1442	26

Family	3M Rate	MFRF Rate	Percent Diff	GIDEP Rate	Percent Diff	RAC Rate	Percent Diff
Washer, Flat	0.5710	0.0767	87	0.0414	93	-	-
Window	0.0274	0.0672	145	0.1418	418	-	-

COMPARISON TO MEDIAN 3M RATE

Family	3M Rate	MFRF Rate	Percent Diff	GIDEP Rate	Percent Diff	RAC Rate	Percent Diff
Adapter	0.0104	0.0460	342	0.0781	651	-	-
Bearing, Ball	0.0345	0.0605	75	0.0513	49	0.0284	18
Belt	0.2371	0.2800	18	0.0121	95	-	-
Bolt, Shear	0.3398	0.0610	82	0.0275	92	-	-
Brush, Elec	0.3667	0.1005	73	-	-	0.0285	92
Bushing	0.0465	0.0540	16	0.0477	3	0.1269	173
Capacitor, Fxd	0.0274	0.0118	57	0.0164	40	-	-
Circuit Breaker	0.1538	0.0320	79	0.0198	87	0.0432	72
Coil, Rad Freq	0.0049	0.0320	553	0.0131	167	-	-
Connector	0.2574	0.0160	94	0.0877	66	0.0103	96
Contact	0.0083	0.0210	153	2.8302	33999	-	-
Coupling	0.0637	0.0420	34	0.1309	105	0.0801	26
Diaphragm	0.1885	0.1000	47	-	-	0.0157	92
Filter, Fluid	0.3636	0.0480	87	0.2020	44	0.2971	18
Fuse, Cart	0.5357	0.4350	19	0.6250	17	-	-
Gage, Pressure	0.2500	0.1400	44	0.1584	37	0.1254	50
Gasket	0.0526	0.1400	166	0.0326	38	0.0226	57
Gear, Hel	0.0323	0.0193	40	0.0324	0	0.0025	92
Indicator	0.0250	0.0320	28	0.1584	534	0.1254	402
Knob	0.0190	0.0146	23	-	-	-	-
Lamp	0.6667	0.2200	67	3.0259	354	0.1117	83
Lens	1.2581	0.0170	99	0.4932	61	-	-

Family	3M Rate	MFRF Rate	Percent Diff	GIDEP Rate	Percent Diff	RAC Rate	Percent Diff
Light, Indic	0.0618	0.0195	68	3.0259	4796	0.1117	81
Motor, A.C.	0.1125	0.0400	64	0.0873	22	0.0185	84
Nut	0.0306	0.0520	70	0.0275	10	-	-
Packing	0.0128	0.1400	994	-	-	0.0304	138
Plug	0.0043	0.0410	853	0.1008	2244	-	-
Relay, Arm	0.0431	0.0360	16	0.0283	34	0.0055	87
Resistor, Fxd	0.0036	0.0136	278	0.0182	406	-	-
Resistor, Var	0.0417	0.0136	67	0.0394	6	-	-
Ring	4.3964	0.0410	99	0.1195	97	-	-
Ring, Wearing	0.1875	0.0410	78	0.1195	36	-	-
Screw	0.0663	0.0420	37	0.0275	59	-	-
Seal	0.5000	0.1145	77	0.3503	30	0.0734	85
Semiconductor	0.0800	0.0170	79	0.0488	39	-	-
Shaft	0.1295	0.0195	85	0.1512	17	0.0404	69
Shim	2.5278	0.0413	98	0.0414	98	-	-
Sleeve	0.1971	0.0500	75	0.1604	19	-	-
Socket	0.0086	0.0250	191	0.0002	98	-	-
Spacer, Ring	0.0625	0.0640	2	0.0414	34	-	-
Spring, Hel	0.0533	0.0380	29	-	-	0.0555	4
Switch, Elec	0.0357	0.0370	4	0.0427	20	0.0301	16
Thermometer	0.1417	0.1950	38	0.0868	39	-	-
Transformer	0.1111	0.0180	84	0.0195	82	-	-

Family	3M Rate	MFRF Rate	Percent Diff	GIDEP Rate	Percent Diff	RAC Rate	Percent Diff
Tube	0.1000	0.0500	50	0.1164	16	-	-
Valve	0.1142	0.0450	61	0.1941	70	0.1442	26
Washer, Flat	0.0455	0.0466	13	0.0414	9	-	-
Window	0.0274	0.0345	26	0.1418	418	-	-

APPENDIX D

DATA FOR SELECTED STOCK NUMBERS ON FF 1060 AND LST 1196

FF 1060 STOCK NUMBERS

NIIN	COG	Name	BRF	MFRF	GIDEP	RAC
000629968	9Z	Bearing, Roller, Tap	0.20	0.0605	0.0726	0.0072
000729408	9N	Resolver, Elec.	0.25	0.024	0.2608	-
000964794	9N	Transformer, Power	0.026	-	0.0195	-
001000636	9Z	Cup, Tapered Roller	0.20	0.053	-	-
001003694	9Z	Cone & Rollers	0.50	0.088	-	-
001004443	9Z	Bearing, Roller, Tape	0.20	0.0605	0.0726	0.0072
001005282	9Z	Bearing, Roller, Tape	0.037	0.0605	0.0726	0.0072
001005289	9Z	Bearing, Roller, Tape	0.01	0.0605	0.0726	0.0072
001104868	1H	Cable Assy, Spec	0.0073	0.032	-	-
001254428	1H	Gasket	6.8	0.14	0.0326	0.0226
001386261	1P	Rod, Assembly	-	0.043	-	-
001557450	9Z	Bearing, Roller, Tape	0.073	0.0605	0.0726	0.0072
001557454	9Z	Bearing, Roller, Tape	0.032	0.0605	0.0726	0.0072
001568051	9Z	Bearing, Ball, Duplex	0.490	0.0605	0.0726	0.0072
001638030	9Q	Insulation, Sleeving	-	0.12	-	-
001651955	9Z	Packing, Preformed	0.1510	0.14	-	0.0529
001909379	9Q	Idler Stop, Pump	0.17	0.0826	-	-
001979599	9Z	Packing, Preformed	0.30	0.14	-	0.0529
002300157	9C	Housing, Rotor, Pump	-	0.0168	0.0603	-
002300158	9C	Rotor, Idler, Pump	-	0.018	-	-
002621076	9C	Valve, Control	0.064	0.045	0.4259	0.1442
002891409	9C	Hose Assy, Nonme	-	0.10	-	-
002938042	9Z	Bearing Roller, Tape	-	0.0605	0.0726	0.0072

NIIN	COG	Name	BRF	MFRF	GIDEP	RAC
003273309	4N	Motor, AC	0.03	0.052	0.0875	0.0185
003512724	4N	Pump, Centrifugal	0.049	0.025	0.7858	1.7887
004503062	2P	Transmitter, Multiple	-	0.037	1.2	-
004567222	2P	Pump, Rotary	-	0.05	0.0713	-
004780373	9Z	Bushing, Sleeve	0.21	0.054	0.0477	0.1269
005545384	9Z	Bearing, Ball, Anulla	0.021	0.0605	0.0513	0.0284
005833917	9G	Motor, Control	0.31	0.04	0.0873	0.0627
006074309	4N	Amplifier Assy, Mag.	0.027	0.05	-	-
006858860	9N	Relay, Armature	-	-	0.0283	0.0055
007282135	9C	Coupling, Shaft, Flex	-	0.042	0.5617	0.0801
007528078	9Z	Bearing, Sleeve	0.51	0.0605	0.0477	0.1269
007528316	9Z	Gasket	0.089	0.14	0.0326	0.0226
007636170	9N	Connector, Plug, Elec	0.084	-	0.0877	-
007977627	9N	Crystal Unit, Quartz	0.0032	0.064	-	-
008829102	9Z	Packing, Preformed	-	0.14	-	0.0529
008940685	1H	Gear Assy, Speed	0.13	0.0087	-	-
009183281	2H	Long OSD E-W ASM	0.17	-	-	-
009188253	2H	Module	0.13	0.051	0.0817	-
009242416	9G	Pickup, Magnetic	0.40	0.046	-	-
009334396	4G	Electron Tube	-	-	0.0251	-
009354955	2F	Projector, Sonar	-	0.10	-	-
009383499	1H	Transistor	-	0.019	0.0013	-
009526610	9Z	Packing, Preformed	-	0.14	-	0.0529

NIIN	COG	Name	BRF	MFRF	GIDEP	RAC
009674827	9C	Lubricator	0.072	0.0975	-	-
009881205	9N	Resistor, Var, W	0.33	-	0.0013	-

LST 1196 STOCK NUMBER

NIIN	COG	Name	BRF	MFRF	GIDEP	RAC
000750495	4G	Frequency, Selector	0.18	0.05	-	-
001005525	9Z	Bearing, Roller, Tap	0.20	0.0605	0.0726	0.0072
001158901	9C	Port Plate, Pump	0.045	0.031	-	-
001158902	9C	Port Block, Pump	0.06	0.0235	-	-
001170715	9Z	Bearing, Roller, Cylt	0.0099	0.0605	0.0726	0.0072
001581076	9C	Coil Assy, Compresso	0.15	0.046	-	-
002252292	9Z	Window	0.073	0.0345	0.1958	-
003448743	6U	Brake Assy	0.025	0.0379	-	-
003892962	4N	Rate Computer	0.084	-	-	-
004206956	9C	Pin, Straight, Headle	0.28	0.027	0.0254	0.0002
005137302	4N	Pendulum Set	0.19	-	-	-
005816298	9N	Relay, Armature	0.19	0.036	0.0283	0.0055
005900944	4N	Sight, Gun	0.64	0.0555	-	-
008780768	2H	Valve, Serve, Hyd	0.33	0.045	0.6854	0.0730

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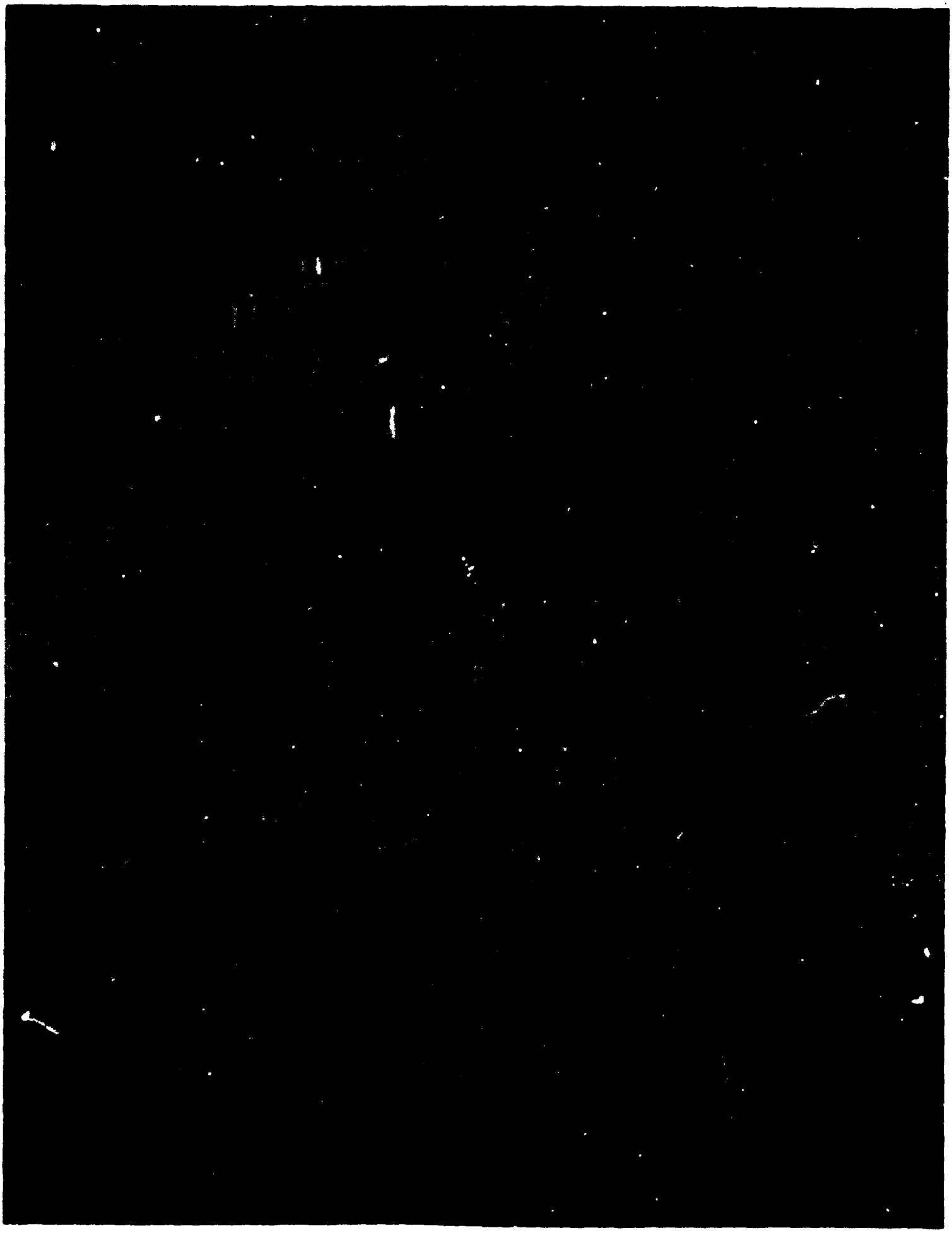


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